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THE RUDISTIDS
OF
SOUTHERN MEXICO

BY

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Formerly Chief Paleontologist and Stratigrapher of the Geological Institute of Mexico

SAN FRANCISCO
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INTRODUCTION

The material discussed in the following pages was in part collected and studied while I was in the employ of the Mexican Government. I desire to express my great appreciation to Sr. Ing. Leopoldo Salazar-Salinas, my friend and erstwhile chief, the former Director of the Instituto Geologico, for his ever ready material assistance in the prosecution of scientific work and for his interest and enthusiasm in advancing the geological knowledge of his country. An expression of appreciation is also due to the staff of the Instituto Geologico for their cooperation and friendly interest. I wish also to express my appreciation to Dr. Bruce L. Clark of the University of California for his interest in this field and assistance in furnishing references to literature, and to the authorities of the library of the University of California for the free use and loan of reference works. The Geological Department of Stanford University very kindly furnished quarters for the cleaning and studying of the material as well as the use of the library. The Mining Department of Stanford University was of great assistance in allowing the free use of their photographic and other equipment. For Dr. J. P. Smith, whose wise and kindly suggestions I have followed with profit and whose assistance is ever available, I have a deep feeling of gratitude. A special debt I owe to my wife, upon whom the drudgery of revising, correcting and typing has fallen and to whose enthusiasm and industry is due the work in its present form.

The type material has been for the most part deposited in the Museum of the California Academy of Sciences. The type of *Immanitas anahuacencis* is the property of the Instituto Geologico de Mexico and is deposited with that institution; paratypes, however, are at the California Academy of Sciences and Leland Stanford Junior University.

Geology

The general area under discussion lies south of an east-west line drawn at about the latitude of 20° north or somewhat north of Mexico City. For the most part only the western or Pacific side will be described.

Physiography: Two physiographic provinces are here represented. The first is the well marked Volcanic Belt that runs east and west across Mexico. This is some 75 miles wide and its axis runs about through Mexico City. It is characterized by a line of semi-active volcanoes and several hundred extinct cones. Between C-Colima[1] on the west and C-Citlalteptl or Orizaba on the east are some of the highest mountains of North America. Among these are C-Toluca, Popocatepetl, Ixtaccihuatl and Malintzi. The notable features are the more or less regularly arranged and spaced volcanic ridges which divide the country into large rectangular undrained valleys with the long axes east-west. The elevation of these valleys ranges from 4500 to 7500 feet.

Basic extrusions completely cover the surface except near the edges of the belt where the underlying sediments have been cut into and exposed by erosion.

South of this Volcanic Belt lies the folded and faulted south end of the Mexican Highland. This has been named the Sierra del Sur Province.[2] It is characterized by numerous mountain ranges and intervening filled valleys which results in the elevation of the highland continuing south to within about 25 miles of the coast where the ridges become lower and lower and finally pass under the ocean on the Oaxaca coast.

Structure: This area presents several distinct characteristics that set it off from all others in North America. The map of Mexico shows that the west coast lies south about 23° east. At latitude 19° the coast line makes a sharp turn to the southeast and its bearing changes to S 70°E. This bearing continues until the longitude of Puerto Angel is reached. It then turns N 70°E and continues in a broad curve along Chiapas forming the Isthmus of Tehuantepec. As is to be expected, all the principal structures maintain approximately the same trend.

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[1] C- is the abbreviation for Cerro, the Spanish word for hill or mountain.

[2] Thayer, Jour. Geol. vol. 24, p. 90, 1916.

Structurally the southern part of this area is simply a large monocline connecting the highland to the north with the low coast country to the south. This monocline is complicated by numerous minor folds and faults. However, any section across this shows the same formations progressively lower to the south as the coast is approached.

The two physiographic units mentioned above suggest that pressure from the south accumulated until the crust folded and broke in the Volcanic Belt. This fractured area afforded conduits for escape to the molten material below. Folding and elevation continued further to the south resulting in the mountainous country that extends nearly to the coast of southern Mexico. Further south the folding was less and took the form of foothills such as are commonly encountered on the flanks of mountain ranges.

The marked east-west structure in southern Mexico from about the latitude 20° 30′ south to the ocean is evidenced not only by the Volcanic Belt but also by the principal ranges, as well as by the shape and direction of the long axes of the valleys and the lakes.

Discussion of the broader aspects of this anomalous structure will be deferred until the faunal relationships are set forth.

Column

Recent		effusives
Quaternary	Pleistocene	effusives and sediments
Cretaceous	Turonian	limestone
	Cenomanian	marine congl. and terrestrial ss. sh. and congl.
Jurassic	Lias	shales and sandstones

Lias: The geologic column in southern Mexico shows but four formations. The oldest formation known at present is the Lias according to Wieland. This is exposed in the Mixteca Alta in western Oaxaca. The flora found there has been described by that author.[8] The beds are composed of sandstones, slates and shales with a few coal seams. Wieland's correlation is open to doubt as fossils of Dogger type have been found in beds that alternate with the plant horizons.

From the Lias until the lower Cenomanian there is no record known in this part of Mexico. Whether these periods were represented by land conditions or by marine sedimentation, the evidence of which was removed during the lower Cretaceous is not known at the present time.

Cenomanian: Above the Jurassic lies the Cenomanian. This formation is of great extent and thickness. It is found in the states of Hidalgo, Vera Cruz, Jalisco, Colima, Michoacan, Guerrero and Oaxaca. In the latter state it is exposed from a few miles south of Ejutla to the coast. For the most part the entire coast between the Isthmus of Tehuantepec west to Colima and for several miles inland is made up of this formation. Practically the only exception to this are the large intrusive masses which form extensive areas, particularly to the east.

The best exposed section known is in the state of Jalisco west of the town of Tamazula. The lowest member exposed is a thin marine bed 100 or more feet in thickness. This is in reality a conglomerate but has the aspect of a limestone from the abundance of fossils and shell fragments that are present. This bed carries a large Rudistid fauna of Monopleuridæ, Caprinidæ and Radiolitidæ types which will be described under "Paleontology." Above this is an enormous series of terrestrial-appearing deposits which are at least 30,000 feet thick with an estimate of 50,000 by one explorer. These are interbedded shales, sandstones and conglomerates with a capping of some 250 feet of gypsum and anhydrite. Throughout the whole formation except for the lowest and highest members the prevailing colors are rich buffs, browns and maroons.

To the south and east are numerous granodiorite and granite intrusions. Towards this direction they become more numerous and extensive until in southern Oaxaca the entire formation has been metamorphosed to schist and gneiss with only isolated areas where its original nature is shown. However, even in the schists and gneisses the presence of quartz and boulders of constituents, alien to the including mass bear evidence of its sedimentary origin.

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[8] Wieland, La flora Liasica de Mixteca Alta. Inst. Geol. Mex. Bul. 31, 1914.

So completely has the aspect of this formation been altered by the intrusions that Aguilera, Felix & Lenk, Thayer and others have ascribed it to the Paleozoic and even Pre-Cambrian.[8a]

It is from the lowest known marine member that the fossils came that are herein described as Cenomanian.

Turonian: This formation is a thick limestone and of very broad extent. It is exposed in San Luis Potosi, Tamaulipas and Vera Cruz where it includes the Tamasopo, at the top of which the oil of the Tampico area is found. It is found in every state between the 20th parallel and the Isthmus of Tehuantepec.

It is of interest in that it is the first of the sedimentary rocks to appear on the edge of the highland from under the extrusive mass that covers the Volcanic Belt. This is the case both on the Atlantic and Pacific sides.

The best exposure known to date is along the railroad from Guadalajara to Colima at the small town of Huescalapa. This is a continuation of the section that was used in describing the Cenomanian.

For the most part it is a hard massive limestone, though locally traces of bedding are seen. Due to its resistant qualities, it forms cliffs and conspicuous features of the landscape. Under lateral pressure it fractures and breaks into large blocks some of which are ½ mile or more long. Through the fracture planes running water cuts deep gorges and caverns. The latter are rather common on the west coast. The well-known caves of Cacajuimilpa in the state of Guerrero were cut in this limestone. To the south and east in the states of Guerrero and Oaxaca it has been metamorphosed to marble by the action of the granodiorite instrusions.

This limestone carries a Rudistid fauna of several species, most of which belong to the family Radiolitidæ. It also contains Foraminifera.

[8a] Thayer, Jour. Geol. vol. 24, p. 92, 1916. Hill, Am. Inst. Minn. Eng. vol. 32, p. 178, 1902.

Heretofore this limestone has been ascribed to the lower Cretaceous and correlated with the Comanchean limestone of Texas.

Quaternary and recent effusives: Over the Volcanic Belt there are some 2000 feet of basalts, andesites and rhyolites. So completely does this material cover the underlying sediments that the latter are but rarely exposed. It is only in the lower valleys such as Cuernavaca and Puebla where the extrusive mantle is thinner that the sediments are exposed by late folding and faulting. In those areas practically the only sedimentary formation exposed is the Turonian limestone. It is only in rare cases that folding or faulting or erosion on the highland has exposed the underlying Cenomanian. However, on the edge of the highland sharp folding and faulting occurred and water courses have cut deep cañons and exposed both the Turonian and the Cenomanian.

Quaternary sediments: Nowhere in this part of Mexico have any recognized Tertiary sediments been encountered.

On the highland, in the valley fill, land-laid Pleistocene with vertebrate remains is not uncommon. On the Oaxaca coast a few miles west of Escondido Bay, a thin bed of marine upper Pleistocene occurs with an abundant and well preserved fauna.

Intrusions: Everywhere along the coast of Colima, Michoacan, Guerrero and Oaxaca there have been post-Turonian intrusions of granodiorite, granite and to a lesser extent diorite. To the west, i.e. in Colima, these are not extensive and occur only in isolated places. However, they become progressively more abundant to the east, as has already been indicated, until along the Guerrero and Oaxaca coasts they form extensive areas. Dykes ten miles long and a mile or more wide with long branches are not uncommon.

The completeness of the metamorphism of the Cenomanian is explained by the thinly bedded structure of the original rocks and the abundant branches of the intruding dykes.

To the north, twenty miles from the ocean, the effect of the coastal intrusions decreases leaving the rocks altered to a much less extent.

There have been three periods of granodiorite intrusions. The first was by far the most extensive. This occurred at a relatively early period as the decomposed state of the rock content bears witness. In the town of Pochutla in southern Oaxaca the decomposition of the granite has progressed to such a degree that a well, 54 feet deep, did not encounter unaltered rock. The second period of intrusion was relatively unimportant. The intrusions cut the older granodiorite and persist as low, narrow ridges in the older rock. These dykes are but little altered. A few traces of a still later period of intrusions are found. These dykes are very small and of no importance.

To these periods may be added a fourth which is of a somewhat different nature. The intruded material is pegmatites along the coast and aplites on the higher edge of the highland. In both of these are a few intrusions of practically pure quartz. Properly speaking, this is not an independent period but rather represents the final stage of the deep seated acidic intrusions.

It seems very certain that these intrusions occurred while the rocks were deeply buried, as the intrusives along the coast are all practically granitoid in texture. However, no trace of the former mantle is known. As stated earlier, the highest member of the column of the sedimentary rocks is the Turonian limestone and only patches of this still persist along the coast.

PALEONTOLOGY

Rudistids: The term "Rudistid" is applied to the aberrant type of sessile pelecypods that developed in tropical and semitropical waters of the Cretaceous seas and of which *Chama* is the sole surviving genus. It is now synonymous with the suborder Chamacea of Fischer. The wide variation in form in this group has given it a checkered career with the systematists. Different members of the group have at various times been placed with the corals, cirripeds, cephalopods, annelids and brachiopods. It was not until the latter part of the last century that a more thorough study of the anatomy of the animals as reflected in the fossil remains, as well as the fossils themselves, has shown that many essential characters of the pelecypods, such as the two valves, the hinge plate, myophore apparatus, shell structure, ligament and in many cases the siphonal areas, were present in the Rudistids and that the bizarre forms were merely due to modifications of common structures.[4]

The Rudistid group is a large one. At present ninety-eight genera and numerous species have been described.

Classification: So extensive has been the play on form and so varied the results that the group does not lend itself to a brief and at the same time adequate description. The various forms, however, may be placed into several groups that admit of a description sufficiently complete to be of some practical use. The genealogy of the Rudistids is so incompletely known that no scheme of classification based on relationship is at present possible. The following is purely artificial and is intended for convenience only. It represents relationship only in so far as resemblance is evidence of relationship.

Diceratidæ-Chamidæ Group: The Diceratidæ include the oldest forms that are definitely known to belong to the Rudistids. They make their appearance in the Lausitanien (Jurassic). Externally their form is suggested by their name, *two horns*. In both valves the umbos turn forward and coil outward as is shown by the anterior view of *Requienia patigiata* (Pl. VI, fig. 5). The two coiled valves resemble the coiling of the horns of a ram viewed from the front. In the genus *Diceras* the two valves are subequal and the umbos loosely coiled and somewhat prolonged to right and left. In the genus *Chama* the coiling is the same but the coils are tight and not prolonged which results in a flat shell (Pl. XVIII, figs. 4, 5).

In other genera the left valve is much the larger and the right valve is reduced to a small bent cone as in *Apricardia* (Pl. VI, fig. 7), or to a small shallow form resembling the segment of an orange as in *Toucasia* (Pl. XVIII, fig. 2), or *Bayleoidea* (Pl. VI, fig. 1); the left valve may be entirely operculate as in *Requienia* (Pl. XVIII, fig. 3). In none of these forms do the vertical radial plates appear (text fig. 1). They were usually attached by the left valve although some,

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[4] **A knowledge of the history of the various classifications of Rudistids is not of sufficient importance to warrant a review. For a summary of this history the reader is referred to "Manual of Mollusca," Woodward, 1871.**

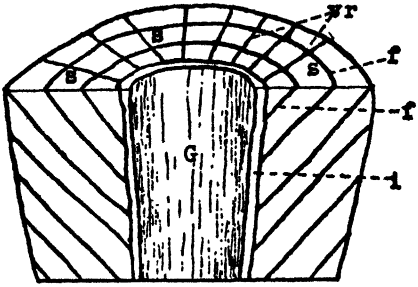

Fig. 1. Diagrammatic sketch of simple radiolitid form; primitive type.

- *G.* Body cavity.
- *i.* Inner shell layer.
- *f.* ***Funnel plates.*** In the early forms these are very near the vertical, *e. g.* ***Agria davidsoni.***
- *vr.* ***Vertical radial plates.*** These are simple and unbranched.

The intersection of the two types of plates forms a mosaic of small squares (*s*) in a horizontal section.

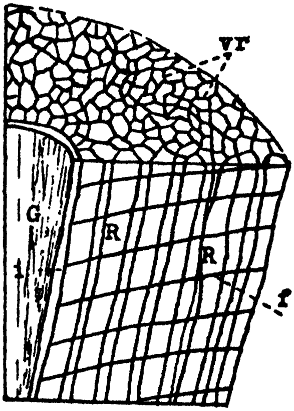

Fig. 2. Diagrammatic sketch of complex radiolitid form; later and more developed type.

- *i.* Inner shell layer.
- *f.* ***Funnel plates.*** Note horizontal attitude which occurs in the forms later than those of fig. 1. These reach the upper surface only near the periphery.
- *vr.* ***Vertical radial plates.*** These branch and form a reticulated or mosaic surface of small polygonal blocks.

The intersection of the branches with the funnel plates results in the rhombic forms (*R*) in a vertical section.

for example *Diceras arietina,* were attached by the right valve.

The surface is usually smooth but may be ornamented by transverse wrinkles or folds due to crowding of the mantle towards the inner part of the coil as in *Bayleoidea clivi* n. sp. It may also have longitudinal ridges as in *Requienia* sp. (Pl. VI, fig. 4).

The shell substance of this group is composed of funnel plates only (text fig. 1). In *Apricardia asymmetrica* there seems to be an exception in the shell structure of the lower valve which apparently has two systems of plates.

Monopleuridæ-Caprotinidæ Group: This group is characterized by the general cone or funnel shape of the lower, attached valve, the presence of but one vertical groove (the ligamental groove) on the surface and by the comparatively small upper valve which may be flat as in *Horiopleura,* somewhat convex as in *Chaperia, Polyconites, Baryconites* and *Monopleura* or it may be capuloid with the excentric umbo or apex situated on the dorsal margin as in *Caprotina.*

The surface is usually ornamented by vertical ridges although some forms may show deep horizontal growth stages as in *Monopleura salazari.*

In this group the shell substance is composed of funnel plates although traces of the vertical radial plates are present in one form, *Baryconites multilineatus.*

Caprinidæ: The general external aspect is well shown in Plates XI and XII. The lower valve is long and cylindrical, may be straight, curved or slightly twisted. The upper valve is always cone-shaped, usually coiled or bent. The ligamental groove is present in both valves.

A very characteristic feature of this group is the presence of the vertical canals in the upper or lower valve or in both valves, formed by the vertical radial plates (Pl. X, fig. 1). The surface may be smooth, vertically striated or transversely ribbed.

Except for the thin, inner layer, the entire shell substance is made up of the vertical radial plates.

Radiolitidæ: This well defined group is described on page 79. The shell material is composed of both vertical radial plates and funnel plates.

Hippuritidæ: This family reached its greatest development in southern Europe. No forms were found in the area under discussion and mention of the group will be made for completeness only.

The superficial aspect is that of the Monopleuridæ-Caprotinidæ group. It differs from that group, however, by the presence of the two deep siphonal grooves in addition to the ligamental groove; these grooves are well shown on the surface of some species but in others are not evident. However, they are always prominent in cross-sections.

The shell is composed of the funnel plates only.

Origin and Relationships: The original stock of the Rudistids is not known. The similarity of the dentition of *Megalodon* that dates from Devonian and continues to the Lias and of *Pachyrisma* of the Trias and Cretaceous to that of *Diceras* suggests that the ancestors of the latter genus may be found in the Megalodontidæ. Douvillé,[5] pointing out the elevated posterior myophore common to *Diceras* and *Pterocardium* of the Rauracien stated: "It is therefore quite probable that this genus *(Diceras)* is derived directly from *Pterocardium* by the fixation, sometimes of the right valve, sometimes of the left valve" (Author's translation.) However, the evidence to date is too meagre to warrant more than a suggestion of relationship.

With the genus *Diceras* in the late Jurassic a few lines of descent seem fairly well established. The similarity of the shell form and the internal structure of the Jurassic *Diceras*, and *Toucasia* of the Urgonian on one hand and *Apricardia* of the Cenomanian and Turonian, and *Bayleia* and *Bayleoidea* of the Turonian on the other hand seems sufficiently strong to warrant the conclusion that this is one uninterrupted stock. Likewise the similarity between *Diceras* and the two genera, *Requienia* and *Matheronia,* which appeared in the Urgonian, suggests another related branch.

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[5] Douvillé, H., Bul. Soc. Geol. Fr., 4th Ser., vol. 12, p. 452, 1912.

In the living *Chama* dating from the upper Cretaceous of Gosau the two coiled beaks and the general organization of the shell also resemble *Diceras*. It seems very probable that the genus *Chama* may be the living representative of an old branch of the *Diceras* stock, which, with this one exception, did not survive the close of the Cretaceous.

The origin of the Monopleuridæ, Caprotinidæ, Radiolitidæ and Hippuritidæ is not known with any assurance. The general similarity of the dentition of these families or groups and their resemblance to that of the *Diceras* stock suggests relationship to Diceratidæ. However, in the Monopleuridæ and Caprotinidæ the operculate form of the upper valve together with the general lack of any trace of coiling in that valve indicate that any relationship with the Diceratidæ is exceedingly remote. The complex vertical radial plates that make up such a large part of the shell material of the Radiolitidæ are not found in the *Diceras* stock. This characteristic structure seems fundamental and in any genetic grouping would widely separate the two groups.

In the Caprinidæ the presence of the vertical radial plates to the exclusion of even a trace of the funnel plates and the bifurcations of these plates resulting in the vertical canals still further remove the Caprinidæ from the older stock.

Concerning the *Radiolites,* Toucas said:[6] "The origin of Radiolites is even less well known than that of Hippurites." (Author's translation.)

The funnel plate structure of the Diceratidæ, the funnel and vertical radial plates of the Radiolitidæ and the latter plates only in the Caprinidæ suggests that if there is any relationship between these three groups, the line of descent was in the order given.

Between the six groups above mentioned there are no common features that are definitely known to indicate relationship. To this there is one exception in the case of the Monopleuridæ and Caprotinidæ whose shell structures and form are the same and which logically belong in the same family.

It is probable that future collecting in the tropical facies of the Cretaceous will supply intervening forms that will serve to bridge the wide gap that at present exists between the five principal groups of Rudistids.

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[6] Toucas, Mem. Geol. Soc. Fr., Paleontologie, no. 36, p. 9, 1907.

Distribution: The Rudistids are confined to the tropical and semi-tropical facies of the Cretaceous. The map herewith gives essentially their known distribution. It will be noted that this is a band that extends almost around the earth and with the exception of the detour around northern Africa, roughly parallels the equator and at the present time lies in the area of warm water. Douvillé has aptly applied the term "Mesogee" to this Cretaceous sea that occupied the old Tethys geosyncline. During Cretaceous time there were extensive incursions of the sea upon the low lying margins of the land. These great physical changes on the earth's surface were accompanied by changes no less marked in the factors affecting organic development. One of the results of this revolution, so to speak, was the curious evolutionary steps followed by the group of Rudistids that found a congenial environment in these warm shallow seas and ran riot both in development of aberrancy and variety of forms and in numbers.

So favorable was this environment to the growth of the Rudistids that their remains accumulated in such quantities that they often constitute the greater part of extensive beds.

In Mexico, the Cenomanian forms are associated with *Orbitolina* which everywhere is confined to warm Cretaceous seas. The abundant coral fauna found with the Mexican Rudistids likewise testifies to their tropical environment.

In Europe the site of the Pyrenees, Alps and the ranges to the east marked the northern boundary of the Mesogee. North of this barrier the Cretaceous fauna, with the exception of a few dwarfed Rudistids, is, on the whole, similar to that of North America north of southern Texas.[7]

In North America east of California Rudistids do not occur north of southern Texas where the forms are small and not frequent as compared with the fauna of Colima and Jalisco. This fact likewise indicates that the cooler waters toward the north limited their distribution.

The Mexican fauna under discussion suggests geological relations that are remarkable. The Cenomanian forms found

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[7] Franke, Zusammenstellung der bisher in nord Europa bekanten Rudisten. Zeit. d. d. geol. Gesell. vol. 63, p. 356, 1911.

February 29, 1928.

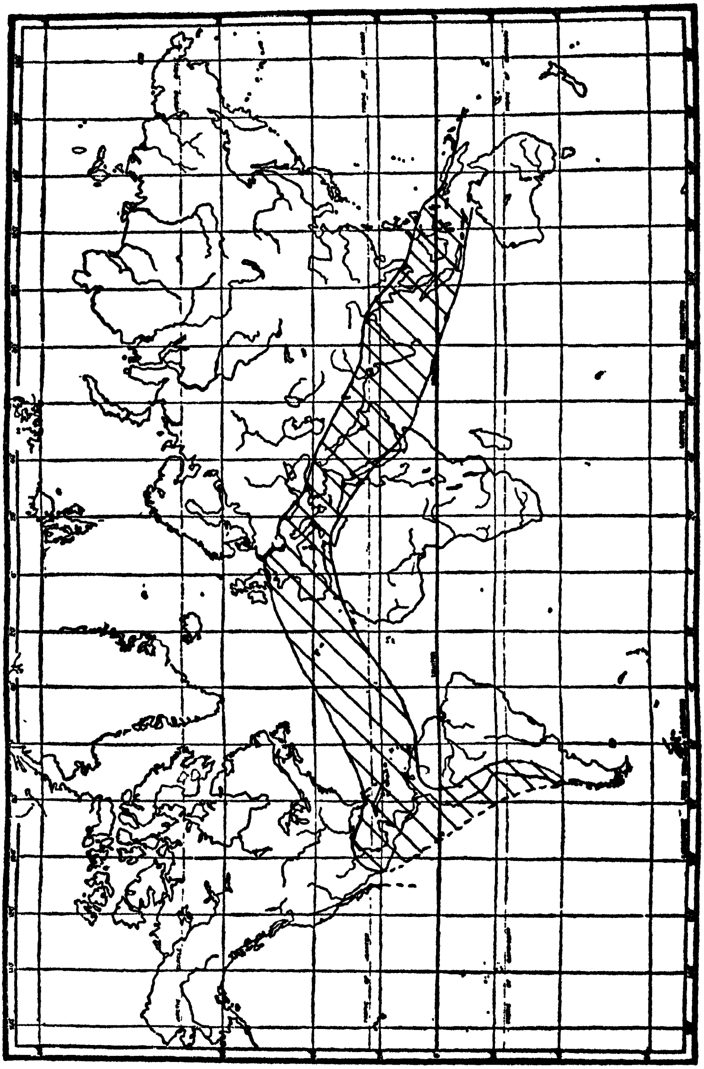

Fig. 3. Sketch map showing known distribution of rudistids by oblique lines.

in the two latter localities occur in shallow water shore deposits where rounded pebbles and boulders are frequent, giving evidence to the littoral habitat of the animals. Were not some of the genera rather narrowly limited by their descriptions, all the new genera except *Planocaprina, Immanitas, Tepeyacia* and *Palus,* would be ascribed to old world genera to which their relationship is apparent.

Concerning the fauna from Coalcoman, Guerrero and from Orizaba in Vera Cruz, Douvillé stated:[8] "The assemblage of forms which we are reporting presents very great analogies with the Sicilian species described by Gemmellaro and di Stefano." (Author's translation.) Schnarrenberger referred two forms, *Monopleura marcida* White and *Ostrea (Chondrodonta) munsoni* Hill, in the Cretaceous of Italy to species described from Texas.[9] *Agria (Eoradiolites, Præradiolites) davidsoni* White, which was described from Texas has also been found in Persia.[10].

In northern South America the Cretaceous carries a fauna similar to that of northern Africa according to a verbal communication from Mr. F. M. Anderson who has collected in the former region and has studied the fauna.

The striking resemblance of the Mexican fauna to that of southern Europe combined with the fact that it occurs in a shore deposit suggests a shallow water connection between southern Europe and Mexico in which migration of these forms was possible. The total absence of any Rudistid genera in the Cretaceous of the Atlantic states and, in fact, of any of the other genera found in southern Mexico eliminates any probability that migration took place through the north Atlantic. No data are at hand to localize this connecting bridge between Europe and Mexico nor between Africa and South America although between the latter the narrowing of the Atlantic between eastern Brazil and western Africa and the intervening high arch in the ocean bottom between them are suggestive. It seems probable that investigation of these two areas on opposite sides of the Atlantic might bring to light faunas that would materially assist in narrowing the limits of the location of this connection. Whether this shallow water connection was a continuous shore or a series of island shores between which free swimming larvæ could be transported by currents is also wholly unknown.

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[8] Douvillé, H., Bul. Soc. Geol. Fr., 3rd Ser., vol. 28, p. 217, 1900. Author's translation.

[9] Schnarrenberger, Ber. d. Naturforschende Gesellschaft zu Freiburg, vol. 11, p. 16, 1899.

[10] Douvillé, H., Bul. Soc. Geol. Fr. 3rd ser., vol. 17, p. 634, 1889.

Another remarkable fact in connection with the Rudistid fauna of southern Mexico is that its affinities are entirely Atlantic. There is not a single genus known that is common to the Pacific Cretaceous of western North America and the fauna of Jalisco and Colima. That there was no temperature barrier is indicated by the presence of the sole Pacific Rudistid genus and species, *Coralliochama orcutti* White, that occurs from Lower California north to the latitude 40° 30′ and by the presence of other warm water genera such as *Trigonia.*

This difference in the fauna of the Cretaceous of southern and western Mexico has been observed by Stanton [11] who accounted for it by the presence of a land barrier between them. Berry also records a similar observation in a discussion of the Cretaceous extension of the seas in the southern United States.[12]

The location of this barrier between the Atlantic and Pacific fauna is as hypothetical as the location of the connection between Mexico and southern Europe though its presence is no less certain.

The presence of the European species, *Agria blumenbachi* and *Requienia ammonia* in Chile and Peru[13] and of *Hippurites bolivensis* Berry,[14] the genus of which is also European and African, suggests that the Cretaceous barrier between the Atlantic and Pacific was some distance west of the present continental mass and that the Atlantic Ocean covered the northern part of South America and also the site of the Andes as far south as the latitude of Chile. The presence of the Cretaceous with a Californian fauna in Lower California indicates that this peninsula might have been the site of the northern end of this land mass while the southern end extended at least as far as Chile before it joined the Cretaceous South American continent.[15]

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[11] Stanton, Bul Geol. Soc. Am., vol. 29, p. 605, 1918.

[12] Berry, Sci. Monthly, vol. 9, pt. 2, p. 131, 1919.

[13] Fritzche, C. H., Neue Kreidefaunen aus Südamerika. N. Jahr. für Min., Beilage Bd. 50, pp. 1-56, 313-334, 1924.

[14] Berry, Pan-American Geologist, vol. 37, 1922.

Rudistids as horizon markers: The bizarre and aberrant forms of the Rudistids combined with their wide distribution and local abundance should render them valuable aids to determine stratigraphic relations in the tropical Cretaceous. This is in accordance with the rule that highly specialized or aberrant faunas have a short vertical range. A few details of the operation of this law may be indicated. The true *Requienia* with the operculate upper valve does not appear above the Urgonian. The deployment of the Caprinidæ during the Cenomanian has already been described and to this may be added the observation that no bifurcations of the vertical plates are reported below the Cenomanian and subsequent to that period the *simple* plates are rare. Among the Radiolitidæ there are several facts of note. Longitudinal sections of the older forms show that the funnel plates form a very acute angle with the shell wall (Pl. XV, fig. 4), which results in a relatively smooth surface and thin shell. In later forms such as *Radiolites perforata,* the funnel plates form a wider angle which results in a thickening of the shell and a foliaceous surface. Still higher, in the Papagallos shales of Tamaulipas, the genus *Sauvegesia* shows these plates to be nearly horizontal. The bifurcation of the vertical radial plates and the coalesing of the branches to form the polygonal canals (text fig. 2), has not been observed below the Turonian. Below this the vertical plates are simple and rhomboidal canals result.

It is highly probable that future observations may modify the above in some details, nevertheless, it is believed that rather definite results may be obtained by the observation and correlation of data on the two classes of plates in the various groups.

It can be asserted with some confidence that with further study, this large group of Mollusca will come into greater use as tools in unravelling the rather complex stratigraphic and correlation problems that tropical Cretaceous geology presents.

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[15] Since the writing of this paper, Mr. R. L. Lupher of the Univ. of Oregon reports the discovery in June, 1926, of the presence of Caprinid and Monopleurid-like forms from two localities in southern Oregon. This is interesting, as it is the most northerly occurrence of Rudistids thus far reported in America.

Determination of rightness or leftness and of normal and inverse forms and of α and β valve: The expressions, "right valve" and "left valve" and "normal forms" and "inverse forms" are common terms in Rudistid literature. They serve no practical purpose in the classification of Rudistids except in the coiled forms and here the use is in the nature of a device rather than a descriptive term based on fundamental anatomical characteristics. However, so general is the use of these terms that they deserve some explanation.

These devices were first invented to describe the shells of the *Chama* group. It was early observed that the shells of *Chama* sometimes grew counter-clockwise, i.e. from umbo to shell opening (Pl. XVIII, fig. 4), and sometimes clockwise (Pl. XVIII, fig. 5). The former were called *normal* and the latter *inverse.* In all forms the ligament is taken as running from the posterior area to the apex of the coiled umbo. This permits the determination of the right and of the left valves by the simple expediency of directing the umbos or ligament away from the observer. Such a rule assumes that the form is prosogyrate, i.e. the umbos point forward. This means simply that when a *Chama* is attached by the left valve it is normal (Pl. XVIII, fig. 4). When the right valve is attached the umbo and the ligament turn to the left and the shell is said to be inverse (Pl. XVIII, fig. 5).

Among some of the Chamæ, whether the shell is normal or inverse depends entirely on the fortuitous circumstance as to whether the young form settled on the right or left side when the free swimming stage came to a close, e.g. *Chama pellucida.* Most of the species of *Chama,* however, are constant in respect to being normal or inverse.

Throughout the group of Rudistids proper there is a decided similarity of hinge plate. It is almost universally the case that one valve has two teeth with a socket between them and the other valve has one tooth with a socket on each side. By convention only, the two-toothed valve is called the α valve and the other the β valve. With the exception of a few species of Jurassic *Diceras* all the known Rudistids were attached by the one-toothed (β) valve and the two-toothed (α) valve was free. One group was attached by the left β valve (i.e. the lower valve) and grew counter-clockwise similar to the Chama shown in Pl. XVIII, fig. 4. By analogy to Chama these are called normal.

It seems to be the case that the attached valve always has, with the one exception pointed out above, but the one tooth, regardless of whether this valve is the right or left, i.e. the valve is always the one-toothed, fixed valve whether it be right or left. A second group developed which was fixed by the right valve, i.e. the right valve became the β valve. This resulted in the shell of the lower valve growing clockwise as is shown in Pl. XVIII, figs. 1, 5. The term inverse was borrowed from the *Chama* nomenclature and applied to this group.

Among the Rudistids many forms show but little spiral form to the beaks and in all the plane of the coil of the upper valve is more or less vertical which renders the application of the above rules as to normal and inverse forms very difficult and impractical. A somewhat safer rule, though merely a rule of thumb, is that when the upper valve is held with the beak upward and the ligament towards the observer the umbo or beak is to the left of the ligament in the normal forms and to the right in the inverse (Pl. VIII, fig. 8).

The above terms and rules, however, are of very limited use except for the Chamæ for which they were invented. For the coiled Rudistids they are of some slight utility. The fundamental objection to them is that they are based on the doubtful assumption that all Rudistids are prosogyrate, i.e. the beaks or umbos are directed toward the anterior. Judging from analogy to the oysters this assumption is not warranted. Although in the majority of specimens of *Ostrea virginica* the beaks bend towards the posterior, i.e. they are opisthogyrate, a large per cent are straight or turn towards the anterior, i.e. are prosogyrate. Among the Rudistids the same condition is not unknown. *Caprinula boissyi* d'Orb.[16] comes well within the definition of inverse forms, i.e. the spire of the upper valve is directed towards the anterior, and is prosogyrate. However, in *Caprina adversa* d'Orb.[17] the spire is directed towards the *posterior* (opisthogyrate), i.e. by the rules determining the *normalness* or *inverseness* this is a normal type. Nevertheless, both are placed in the inverse group.[18] *Schiosia* and *Coalcomana* are both placed in the inverse group by Harris & Hodson[19] yet the *Schiosia schiosensis* Boehm,[20] the type of the section, has, according to the rules, a normal form.

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[16] d'Orbigny, Paléontologie française, Terrains crétacés, vol. 4, pl. 540, 1847-9.

[17] d'Orbigny, Paléontologie française, Terrains crétacés, vol. 4, pl. 536, 1847-9.

These terms, although very generally used have a looseness of application that makes them of doubtful value and apparently the practice is another illustration of an attempt to found a classification upon a basis that is purely artificial and does not take relationships into consideration. Until relationships of the various forms of Rudistids are ascertained and the structures better understood it seems preferable to avoid the use, at least of the terms normal and inverse, except as originally applied to *Chama.*

Age of Fauna. Rudistids from Paso del Rio, Colima and Soyatlan de Adentro, Jalisco: The forms from Soyatlan de Adentro in Jalisco and those from Paso del Rio, Colima both lie at the bottom of a thick series of deposits that appears to be terrestrial in part. In both localities there are a few identical species including well preserved *Cidaris* spines and an *Acteonella.* These two facts seem to warrant the conclusion that the two localities are in reality in the same horizon if not actually the same bed.

It is regretted that the use of formational names current in the United States cannot be used in describing this faunal horizon. The fauna is entirely European in its affinities and its location with reference to the Cretaceous column of the United States is not known with sufficient assurance to warrant the use of any formational names except those of Europe. The Cenomanian is usually taken to be about the equivalent of the Washita and the Turonian is considered equivalent to the Eagle Ford in the Texas column. This, however, is not the opinion of the writer.

In view of the fact that the species described are all new except one, *Coalcomana ramosa* (Boehm), direct comparison with species from determined horizons is impossible and comparison with other faunal assemblages must be resorted to.

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[18] Douvillé, H., Sur quelques formes des Chamidés. Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, pp. 781 and 784, 1887.

[19] Harris & Hodson, Paleontolgraphica Americana, vol. 1, no. 3, p. 9, 1922.

[20] Boehm, G., Berichte de Naturforschende Gesellschaft zu Freiburg, vol. 6, 1891.

The abundant Caprinid as well as the very common Monopleurid fauna in the two Mexican localities mentioned, find their closest counterpart in the Schiosia beds near Termini-Imerese in Sicily,[21] concerning the age of which Douvillé[22] stated: "I have already indicated that the *Caprotinidæ (Sellæa)* beds and the *Caprinidæ (Schiosia)* beds of Sicily are very probably also Cenomanian." (Author's translation.)

North of the Adriatic Sea in the foothills of the Alps near Lake Croce, occurs a fauna that has long been known. In it are found the genera *Schiosia, Caprina, Sphærucaprina, Nerinea, Monopleura* and *Apricardia.* With the exception of *Apricardia,* all these as well as very similar species have been found at C-Escamela, near Orizaba, in the state of Vera Cruz, Mexico. Boehm[23] pronounced the Italian forms upper Cenomanian. Concerning the Mexican fauna the same author[24] stated: "I believe one would not be mistaken if he referred our Escamela limestone to the upper Cenomanian." (Author's translation.) Douvillé obtained a Rudistid fauna from Coalcoman, Guerrero among which was *Schiosia ramosa* (Boehm) which lead the author to conclude, with some reservations: "Il serait naturel, j'en conclure que les couches a Rudistes du Mexico sont egalement cenomaniennes . . ."[25] The occurrence of *Coalcomana ramosa* (Boehm) as well as a similar faunal assemblage in Vera Cruz, Guerrero, Colima and Jalisco seems to warrant considering the Colima and Jalisco localities simply as new localities for the occurrence of a formation already known.

Futterer[26] reached the same conclusion concerning a similar fauna which he described from Casera Fassor near Traviesio, Italy, which is some 26 miles east of Lake Croce. This contains *Schiosia (Caprina) schiosensis* Boehm and *Caprinula* sp.

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[21] di Stefano, Atti R. Accad. di S. L. e A., vol. 10, 1888; also di Stefano, Paleontographica italica, vol. 4, p. 1, 1898.

[22] Douvillé, H., Bul. Soc. Geol. Fr., 3rd Ser., vol. 28, p. 217, 1900.

[23] Boehm, G., Ein Beitrag zur Kenntniss der Kreide in den Venetianer Alpen. Freiburg Naturforschende Gesellschaft, vol. 6, p. 14, 1891.

[24] Boehm, G., Zeit. d. d. geol. Gesell. vol. 50, p. 332, 1898.

[25] Douvillé, H., Sur quelques Rudistes americains. Bul Soc. Geol. Fr., 3rd ser., vol. 28, p. 31, 1900.

[26] Futterer, Über einige Versteinerung aus der Kreideformation der karnichen Voralpen. Palaeontologischen Abhandlungen von Dames und Kayser, VI, n. f. 11, p. 356, 1896.

This fauna he tentatively placed in the lower Turonian or upper Cenomanian.

The Caprinidæ are known from the Urgonian although they were sparsely represented at that time nor did they occur in any great numbers during the Aptian and Albian. In the Cenomanian, however, a great deployment took place and their remains are found in great numbers in many localities of the tropical facies of the rocks of that age. The abundant Caprinid fauna in the two Mexican localities, it is reasonable to conclude, represents the western extreme of this Cenomanian deployment.

The position of the Rudistid bed or beds within the Cenomanian is not entirely clear. From its stratigraphic position at the base of some 30,000 feet of conformable sediments it would seem to be a valid assumption that it is lower Cenomanian. The presence of *Horiopleura,* a typical Albian genus, points to the same conclusion. Concerning the age of the fauna of Paso del Rio, Dr. E. Angermann thus expressed the same opinion as shown below.[27]

Rudistids from Huescalapa, Jalisco: The genus to which most of the forms from this locality belong is *Radiolites,* which did not make its appearance elsewhere until the early Turonian (p. 80) although it persisted to the Campanien. The genus *Apricardia,* which occurs in the same limestone is not known above the Turonian. This marking of the upper and lower limits permits the stratigraphic position of the Rudistids of Huescalapa to be placed in the Turonian with considerable assurance.

The very close resemblance between *Radiolites perforata* and *R. liratus* of the Turonian as figured and described by Parona from Syria[28] is further evidence of the age of these forms. Its stratigraphic position above the beds of Paso del Rio and Soyatlan de Adentro is in harmony with this view.

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[27] Angermann, E., Notas geologicas sobre el cretacico en el estado de Colima. Instituto Geologico de Mexico, Paragones, vol. 2, p. 32, 1907.

Author's translation: "These strata contain beds filled with fossils which cannot be determined specifically. They belong to the genera Trigonia and Ostrea (Gryphæa). Above these beds rest limestones with cf. *Pecten (Vola) quadricostatus* Sow. var., Roem., which will be mentioned later. From this data only I have decided to attribute these beds to the lower Cenomanian."

[28] Parona, Atti della R. Accad. Sc. di Torino, vol. 44, p. 491, 1908-9.

The Rudistids occur in a high limestone cliff which, as has been mentioned above, is part of the extensive limestone that is found widely distributed throughout Mexico and which has been correlated with the Comanchean of Texas by older geologists.[29] Stanton speaks of isolated patches in Puebla and Guerrero that are referred to the upper Cretaceous and adds "but in general the upper Cretaceous seems to be absent from southern Mexico."[30]

One of the striking facts in connection with the fauna of Huescalapa is the absence of the Hippuritidæ. This family is abundantly represented in the Turonian of southern Europe and its absence in this locality thus far has no explanation. Throughout the whole extent of the Turonian limestone in Mexico but few Hippuritid forms have been noted. Castillo reports a few forms collected near Zumpango on the eastern edge of the Valley of Mexico and the writer found several specimens in a Tamasopo limestone boulder (Turonian in part) that came from an Oligocene conglomerate in Vera Cruz. Several genera from the upper Cretaceous beds of Jamaica are reported by Trechmann.[31] The genus *Hippurites*, however, is not found in Jamaica for the probable reason that the horizons are somewhat too high in the column.

At Huescalapa, Jalisco, there is about 1000 feet of Turonian exposed in a steep and conspicuous cliff. It is a rather pure limestone that is quarried and burned for lime. The calcite of all the fossils exposed is replaced by quartz. It is worthy of note that this replacement occurs only at or near the surface, i.e. it takes place as the shell is exposed by erosion. Within a millimeter the replacement is not complete and becomes progressively less with depth and disappears entirely at 10 mm. or so.

Beekite is also common on these quartz-replaced fossils (Pl. XVII, fig. 5).

None of the Rudistid genera occurs exclusively in any horizon of this exposure but they are scattered through the entire formation. However, *Requienia* and *Bayleoidea* are more abundant in the upper part and the *Radiolites* in the lower.

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[29] Hill, R. T., Am. Jour. Sci., vol. 145, p. 307, 1893.

[30] Stanton, Bul. Geol. Soc. Am., vol. 29, p. 685, 1918.

[31] Trechmann, Geological Magazine, vol. 61, p. 395, 1924.

List of Rudistid Genera: American and European Occurrence

Genera	America	Europe	Genera	America	Europe
Agria	x	x	Monopleura	x	x
Apricardia	x	x	Palus	x	
Baryconites	x	x	Planocaprina	x	
Bayleoidea	x		Polyconites	?	x
Caprinula	x	x	Radiolites	x	x
Caprinuloidea	x		Requienia	?	x
Chaperia	x	x	Sabinia	x	x
Coalcomana	x		Schiosia	?	x
Horipleura	x	x	Sphaerulites	x	x
Immanitas	x		Tepeyacia	x	

SYSTEMATIC PALEONTOLOGY

Immanitas Palmer, new genus

Shell equivalve, large and irregular in shape, recumbent, arched or loosely coiled and usually in a very low spire. Shell substance composed of fine, rounded or polygonal prisms or tubes which appear as striations on the surface. The tubes near the interior are often septate.

Upper side with large, rounded rope-like ridge (W) that may be either well exposed or completely buried by a fold in the shell wall; lower surface smooth or longitudinally ribbed with three ridges and two low furrows. The ridges cover the three longitudinal tubes or cavities that extend the entire length of the shell near the surface and the grooves are the areas between them (Pl. II, fig. 2). In *I. rotunda* there are but two of these cavities and they are deeply buried, hence the ridges do not show at the surface. In no specimen seen is there trace of myophores.

The dental apparatus is very rudimental. It consists of two protuberances with an intervening depression in one valve and two corresponding depressions and a tooth in the other. These are located in the dorsal concave side. They differ from all other rudistid forms of teeth in being located in the shell wall itself instead of being distinctly specialized organs located within the internal cavity. The body cavity is very small. Even in the larger forms it is but an inch or so in diameter. This is septate in the two species known. The lack of proportion between the fleshy and the hard parts suggests an adaptation that only slight changes of physical conditions might destroy and hence a short vertical as well as horizontal range to the genus.

This genus was represented by very large forms. The outside measurement of the valve figured in Pl. III is 24 inches. In one specimen imbedded in the rock there was exposed 25 inches; this included only the outside measurement and not the total length as represented by the coil nor by the part not exposed by erosion. The type of the genus (Pl. I) is 16 inches long, 5¼ inches wide and 25 inches between the umbos measured on the rope-like fold.

The origin and relationships of this genus are not known. All that can be said of the latter is that it is a bivalve. The tubular structure of the two valves suggests the *Caprinidæ* but here the similarity ceases. The same feature, the recumbent habit and the large size were also features of *Caprinella.* Both the above had a well developed ligament and internal dentition, which are wholly lacking in *Immanitas.* The cavities *X, Y* and *Z* and the rope-like fold, *W,* along the upper surface are unknown in any genera described to date.

Titanosarcolites, Trechmann, from the Cretaceous beds of Jamaica bears some resemblance to this genus in its large size, recumbent habit, equality in the size of the two valves, the ridges and sulcations and the lack of a ligament. However, the three well-defined cavities *X, Y* and *Z,* the rope-like fold and the unique dentition readily distinguish *Immanitas* from the Jamaican genus. Trechmann states that *Titanosarcolites* probably belongs to the Radiolitidæ though the evidence of relationship is not clear. *Immanitas* cannot be referred to that family because it lacks the funnel plates characteristic of the Radiolitidæ.

At present it seems impossible to ascribe this genus to any family now known. However, it is deemed best to await the discovery of additional species before any attempt is made to describe a new family.

Representatives of the genus occur in such abundance at Paso del Rio, Colima, that they form probably one-third the entire content of a bed 15 or 20 feet thick. Unfortunately diorite dykes have intruded the sedimentary rocks and recrystallized the lime of the shells and broken them into fragments making very difficult the securing of good specimens.

The type of the genus, *I. anahuacensis,* and probably *I. rotunda* lay prone on the sea bottom but were *not* attached.

1. **Immanitas anahuacensis** Palmer, new species

Plates I, II, III, IV

Large, flat, equivalve, irregularly coiled bivalve. The specimens at hand all show a tendency to form a low spire. However, this spire is so low that it did not in any way interfere with the prone position of the animal which the heavy and large-sized shell required. The form of the shell varied from a crescent (Pl. I), to a coil of two or more turns. Except for the tendency towards this form the shell does not maintain a definite shape as it evidently conformed to the configuration of the sea bottom on which it grew. The coiling is such that the dorsal side is always concave. The cross-section is quadrilateral and flattened.

The upper side of both valves is ornamented by a low, rounded furrow or fold *(W)* between two grooves. The under side is rather flat and towards the marginal side shows three low, rounded ridges and normally two inconspicuous, shallow grooves. The ridges mark three large, longitudinal cavities *(X, Y* and *Z)* that extend the length of both valves. These ridges often are removed by erosion exposing the cavities below. The entire shell mass of both valves is made up of minute polygonal canals or prisms which give the surface a fibrous appearance. The dorsal side is flat and makes a sharp angle with the upper surface. On the periphery is a large keel which borders the area that rested on the sea bottom.

The dentition is imperfectly known. Only one specimen shows any trace of the teeth or of the union of the two valves. That specimen shows two teeth in one valve and one in the other which are merely rudely specialized parts of the shell wall and not special internal structures as in other rudistids. In all the other specimens, recrystalization has obliterated all traces of any hinge structure.

Cross-sections add a few important details. The body cavity is extremely small, being less than an inch in diameter in some of the larger specimens. In all cases where observed it is closely septate. There is no trace of a ligament either externally or internally.

The three cavities, *X, Y* and *Z* (Pl. II, fig. 2), in the under side are large tubes that are somewhat polygonal in outline. The two outer ones are subequal and larger than the inner one. Their function is not known. These cavities are never septate as far as has been observed except near the umbos and often are filled with calcite with a fibrous or cellular structure of a kind not found in the form assumed by calcite of a cavity filling. This structure is shown in the cross-section of *I. rotunda* (Pl. V, fig. 1). This is suggestive that there may be reflected here, structures of the soft parts of the animal. As no ligament is present and the rudimentary tooth and socket arrangement could in no way hold the two valves together and, the fact that these cavities are in both valves and opposite to each other render it not improbable that the cavities housed fleshy organs that functioned as a ligament or as adductors. Their position, however, is not on the dorsal side, making it unlikely that any one of the three is homologous to the true ligament.

The large rounded or rope-like band *(W)* (Pl. II, fig. 1), between the grooves *a* and *b* shows in cross-section as a hollow cylinder lying in a deep furrow and attached only by a ventral strip *c*. Some specimens show *c* to be very narrow. *(W)* apparently was hollow. The interior is filled with calcite and not with silt which indicates that *(W)* was a septate tube. Its function is not known.

In this species the tubes that make up the substance of the shell are capillary in proportions. On the upper surface they average 26 to the centimeter and on the lower 26 to 55. Towards the interior of the shell these tubes are septate but the outside ones are not.

Holotype: Nos. 19205, 19206, Collection of Instituto Geologico, Mexico, D. F.; *paratype,* No. 2154, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; Dec., 1921; Cenomanian, Cretaceous.

This curious form is so abundant that fragments make up a third of a limestone bed some 15 feet thick. Unfortuntely, the preservation is not good owing to diorite intrusions that have fractured and recrystallized the fossil content.

The species receives its name from Anahuac, the Aztec name of Mexico.

2. **Immanitas rotunda** Palmer, new species

Plate V, figure 1

Only a short but well preserved fragment is known. The cross-section is round though slightly bevelled on one side (Pl. V, fig. 1). The whole shell substance is composed of small tubes as in *I. anahuacensis* n. sp. *X* and *Y* are deeply buried and are not represented at the surface. *W* is also deeply buried; the folds in the shell wall have completely engulfed it and joined above leaving no trace. Body cavity small and septate. *X* and *Y* are joined on the internal side forming a single cavity which is U-shaped in cross-section. In both of these tubes or U-shaped cavity, cellular aggregations are present which suggest soft tissue.

This species was probably unattached as was the case with *I. anahuacensis.*

Holotype: No. 2155, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

The barest trace of a bevel on one side may indicate that *I. rotunda* was a partially erect form and not recumbent as was *I. anahuacensis.*

This species contains but two of the large longitudinal tubes: *X* and *Y*. The well defined polygonal structure of the filling material is very suggestive that these tubes were filled with organized tissue of the animal. These may represent the myophores in which were lodged the adductors.

This species is placed in *Immanitas* from its general similarity to *I. anahuacensis,* the prismatic structure of the shell and the small septate body cavity, and *W,* which seems entirely analogous to *W* of *I. anahuacensis,* though deeply engulfed. On the other hand, the presence of only two of the cavities, *X, Y* and *Z,* indicates a difference which may be generic. The species is named from sections only.

Palus Palmer, new genus

Lower valve straight; surface grooved or corrugated. Shell wall composed of three distinct layers: (1) an inner, thin and homogeneous; (2) a middle, thick layer of porous material, the porous structure being composed of polygonal canals and possibly accessory cavities; and (3) an outer layer composed of closely set and compact funnel plates. Throughout the outer layer are small grooves that extend nearly through to the middle layer. These grooves are close folds in the outside layer and result in the corrugated or finely fluted surface of the shell. The grooves widen at the base into canal-like structures. Near the aperture only the outer layer appears (Pl. V, fig. 2).

The myophores are superficial and inconspicuous; they appear as thickened or roughened areas on the interior surface.

The hinge plate is small and weak: *b* and *b′* are reduced merely to grooves (Pl. V, fig. 2).

Upper valve unknown.

The fact that the teeth and their keels are small and appear to be somewhat rudimentary, casts doubt as to the wisdom of placing these forms in the Caprinidæ.

Type of the genus: *Palus corrugatus* n. sp.

3. **Palus corrugatus** Palmer, new species

Plate V, figures 2-5; plate XVII, figures 6-8

Shell small, straight and corrugated externally; shell wall thick at the base and thinning towards the summit, that is, the internal cavity is deeply concave and is filled with the spongy material as the shell grows and the animal withdraws. In other rudistids the withdrawal stages are usually marked by partitions or septa. As a result of the filling of the internal cavity the hinge apparatus is obliterated except at or very near the aperture. This porous layer was effectively sealed off by the thin compact inner shell layer (Pl. V, fig. 4).

N is very small and inconspicuous; the flanges *Dp* and *Va* are rudimental, only partially enclosing the tooth sockets *b* and *b′*; *Vp* is absent, hence there is no cavity *m*; *Da* is conspicuous. (For explanation of *b, Vp* etc., see Pls. X and XI.)

The myophore *ma* is merely a thickened, wavy, superficial area and *mp* is not visible. The ligament is internal and appears on the surface as an inconspicuous rounded crease.

The upper valve is unknown except for the ends of the teeth that were broken off in the sockets of the lower valve. *B* was larger than *B'* and was provided with the two keels *V'a'* and *V'p'* (Pl. V, fig. 2). It is probable that these made low partitions in the upper valve.

Syntypes: Nos. 2156, 2157, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

The three well defined shell layers with the tube-like folds in the outer probably remove this genus from the Caprinidæ and from any other known family or genus.

The tube-like structures in the outer layer are clearly due to foldings in the outer layer as Douvillé suggested for the origin of the tubes or canals in the Caprinidæ. The so-called canals of the Caprinidæ may be, however, homologous to the tubes of the middle layer *Palus* and not to those of the outer layer. The middle shell layer seems to be secreted in the form of tubes in order to render the shell below the animal the strongest and most solid from the least material.

This species lived both in colonies and singly. It is very abundant at Paso del Rio, Colima.

Diceratidæ Dall

The external form has been sufficiently described under the general description of the Diceratidæ-Chamaceæ group. The myophore and dental apparatus vary so greatly that no general description can be applied to all the genera. Furthermore, the two valves are usually joined and the matrix in which they are bedded so indurated that it is impossible to expose the internal structures. This results in the hinge apparatus of many forms being still unknown. The known data on the hinge plate of this family as far as it is represented in the fauna of southern Mexico, are given under the generic and specific descriptions.

One species, *Bayleoidea clivi,* belonging to this family, retains the primitive character of being a free form and not sessile. This species, together with *Immanitas anahuacensis* and probably *I. rotunda,* of the described fauna possess this characteristic.

Bayleoidea Palmer, new genus

The genus *Bayleia* is indistinguishable from either *Toucasia* or *Apricardia* externally. The type of the genus, *B. pouechi* Mun.-Ch. and *B. subæqualis* d'Orb., both from the Turonian of France have, except for minor details, the external form of *Apricardia* (Pl. VI, figs. 6, 7). The similarity between *Toucasia* and *Apricardia* is expressed by Douvillé as follows: "Extérieurment, les *Apricardia* ont exactement la même forme que les *Toucasia.*"[32]

Each of the three genera shows considerable variation in the amount of coiling of the valves but among them there is no fundamental difference. All three genera become fixed by the left valve, i.e. normally. They are separated from each other by the character of the hinge plate and muscular myophores and the ligament. The arrangements of the myophores of *Apricardia* and *Toucasia* are set forth under the discussion of the former genus. Douvillé[33] gives a diagrammatic description of the cardinal apparatus of *Bayleia* from a view at right angles to the plane of the shell opening. Later, the same author described[34] sections of *B. subæqualis* taken through the hinge of the engaged valves normal to the plane of the shell opening (text figs. 1, 2). A new form in the Mexican fauna corresponds essentially to this description (Pl. VI, fig. 2).

Munier-Chalmas,[35] described Bayleia as follows:

> "Valve α free, very convex and deep. The umbo is coiled on itself in such a manner that it forms a very pronounced spire; the early whorls are tight, the later are loose . . .
>
> "Valve β fixed. Umbo twisted, loosely coiled and well developed. . . ." (Author's translation.)

The new form illustrated (Pl. VI, figs. 1-3), shows that the lower, left, valve is a low open spire and the upper, right, valve is semi-operculate and not spiral. The limiting of *Bayleia* to spiral beaks or umbos excludes this form from that genus.

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[32] Douvillé, H., Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 764, 1882.

[33] Douvillé, H., Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 795, 1882.

[34] Douvillé, H., Bul. Soc. Geol. Fr., 4th Ser., vol. 11, p. 192, 1911.

[35] Munier-Chalmas, Etudes critiques sur Les Rudistes. Bul. Soc. Geol. Fr., 3rd Ser., vol. 10, p. 491, 1882.

The close agreement of the hinge apparatus of the two, however, suggests relationship and the name *Bayleoidea* is given to this new genus.

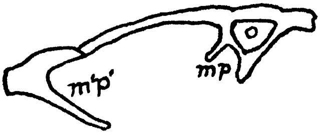

Fig. 4.

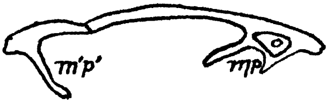

Fig. 5.

Figs. 4, 5. Diagrammatic views of hinge of *Bayleia subaequalis*; (after Douvillé).

Lower valve on left; upper valve on right.

m'p'. Posterior myophore of lower valve.

mp. Posterior myophore of upper valve.

The salient characteristics of the genus may be summarized as follows: The general form is that of a cone somewhat flattened and coiled about ½ turn. Very inequivalve, lower valve making up most of the shell, upper valve semi-operculate resembling a section of an orange. The external appearance is so closely duplicated by a Neocomian *Toucasia* that the latter is used for the purpose of illustrating the general form (Pl. XVIII, fig. 2).

The lower valve is keeled and is rounded or swollen on the lower posterior side and the anterior upper side is more or less flattened. The animal lay prone instead of being fixed by one of the beaks. It was attached by or rather lay upon the posterior side of the left valve. This gave it the appearance of an inverse shell, though it is in fact normal.

The shell of both valves is very thin.

A cross-section of the hinge apparatus and myophores is illustrated in Pl. VI, fig. 2. Compared with the heavier hinge plate of the older forms this plate seems to indicate a progressive weakening or degeneration of this essential part of the shell. This section of the hinge shows only the edge of the upper valve corresponding to a tooth butting into a low flat area which corresponds to a socket in the lower valve. How the muscular myophores functioned is not known as they cannot be completely exposed in the section.

The close resemblance of this genus to *Toucasia* externally and the analogies between the myophores of the two genera suggest that *Bayleoidea* is the Turonian representative of the Neocomian *Toucasia*. The internal difference between the two is in part bridged by the genus *Bayleia*, though it is entirely possible that more complete knowledge of the two would show that their myophores are the same.

The most curious difference between this and *Toucasia* is the fact that it was attached or rested on the posterior in place of the anterior side. With the exception of *Bayleia* this feature is unique in the described forms. This could take place only in a shell where one valve was long and tubular and the other was semi-operculate. By way of illustration, if the union between the two valves (Pl. XVIII, fig. 2), were at the line drawn near the periphery, as is the case in the Chamas, it is clear that a turning over and attaching by the anterior side would involve a shifting of the area of attachment from the right to the left valve (i.e. the normal form would become inverse), while with the semi-operculate upper valve of the *Toucasia* illustrated, a turning over of the shell so that the posterior side becomes the attached side leaves the same valve the attached valve and the result is a *Bayleoidea* with the *attached* posterior side. In other words, by simply inverting a *Toucasia*, the form of a *Bayleoidea* results and the converse is equally true.

Stated in still another way, *Bayleoidea* would have been an inverse form had the right valve been sufficiently large to afford a space for attachment when the animal turned over or shifted so as to become attached by the posterior side in place of the anterior.

Type of genus: *Bayleoidea clivi* n. sp.

4. **Bayleoidea clivi** Palmer, new species

Plate VI, figures 1-3

This is a rather generalized form externally. Its general appearance is given in the description of the genus. The under (posterior) surface of the left valve is rounded and smooth and shows no trace of siphonal areas. The animal was attached by or rested upon the entire posterior surface of the left valve. The margin of the attached area is limited by a conspicuous peripheral keel that runs the entire length of the shell. The upper, anterior surface is marked by many irregular, rounded, radiating, transverse wrinkles. This surface is also ornamented by numerous, shallow, longitudinal bands.

The upper valve is semi-operculate of the type common in *Apricardia* and *Toucasia* (Pl. XVIII, fig. 2); i.e. the anterior surface is flat and operculate while the posterior is a lune. The ligament is internal in contrast to that of *Bayleia* (Pl. VI, fig. 2).

The details of the hinge plate and of the myophores, as far as known, are set forth in the description of the genus.

Holotype: No. 2158, Mus. Calif. Acad. Sci., from **Huescalapa, Jalisco**; collected by R. H. Palmer; Aug., 1922; Turonian, Cretaceous.

This species occurs in abundance near the top of the Turonian at Huescalapa, though on account of the thinness of the shell remains are usually fragmental. It is also found scattered through the entire formation, though rather infrequently.

Diceras favori Sharpe, of the Turonian of Portugal, closely resembles the form at hand except that the former is more equivalve.

This species is noteworthy in being a free form, i.e. not attached by either valve.

Requienia Matheron 1842

Plate XVIII, figure 3

D'Orbigny has summarized the characters of the genus *Requienia* as follows:

> "Shell fixed, testaceous, thick, of a lamellar texture, very inequivalve, always lying on the side; lower valve fixed on the sea bottom by a very large part of the surface; very oblique, spiral at all ages. Upper valve smaller than the other, convex or not, and often twisted into a lateral hook. No ligament? Hinge? The two muscular attachments in each valve very large.
>
> "Internal apparatus formed in the two valves and on the upper side only. It is composed of one or two strongly jutting plates that extend from the aperture to the beak. Sometimes these plates are lacking.
>
> ". . . Shell smooth, transversely ridged or striated or longitudinally costate." (Author's translation.)[36]

The system of coiling in this genus is of interest as it greatly assists in the interpretation of it. In young forms the whole side of the shell was attached and the coil grew in a horizontal plane. Later by the elevation of the ventral side the plane of the coil became vertical.

The genus is now limited to forms with the right (upper) valve operculate or nearly so.

5. **Requienia** sp.

Plate VI, figure 4

This form is attributed to *Requienia* from its general resemblance to *Requienia patigiata* White of the Edwards Limestone, Albian, of Texas. The fragment is part of the left valve and shows a few characters that are distinctive. The umbo has two or more turns; the upper surface is covered with numerous (22±) fine, longitudinal ridges and a few radiating wrinkles; the periphery is keeled; the lower surface is smooth except for one shallow sulcus just below the keel. It was attached by the right valve. With the exception of the ornamental ridges on the upper surface, the Texas form also answers to this description. The shell is thin. The specimen figured is 1¾ inches long. Internally two low ridges extend along the inner surface of the shell; these are the myophores for the adductors.

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[36] d'Orbigny, A. Paléontologie français. Terrains crétacés, pt. 4, p. 247, 1847.

The Texas form above referred to is very probably incorrectly ascribed to the genus *Requienia* as that is a Neocomian genus. Furthermore, *Requienia ammonia* d'Orb., the type of the genus, is a normal form attached by the left valve, and the right valve is operculate, while *R. patigiata* is inverse, attached by the right valve, which is spiral and well developed (Pl. VI, fig. 5). However, the specimens at hand are too fragmentary to supply sufficient characters to warrant the description of a new genus.

This fossil is abundant at the top of the Turonian at Huescalapa, Jalisco, but is found throughout the formation. The shells were very thin and, though replaced by quartz, only fragments have survived the effects of erosion.

Apricardia Gueranger 1853

This genus is represented by medium sized, crescent, disclike forms varying from two to three inches in diameter and an inch in thickness. When the two valves are joined they have a general crescent shape with each horn somewhat coiled. The two valves are not symmetrical due to the fact that the upper or right valve is very much the smaller. In some species the upper valve has a flat umbonal area. The shell was attached by the umbonal area of the left valve. The form of attachment required that the umbonal surface be directed downward (Pl. VI, fig. 7).

The periphery of the left valve may be smooth as in *Apricardia chavesi*, n. sp., keeled, as in *A. toucasianus* d'Orb. or both valves may be keeled as in *A. archiaci* d'Orb. During the early stages the animal was attached on the entire ventral side and this keel marked the limit of the attached area. Later, the shell grew beyond the attached area though in many forms the keel propensity continued.

The genus was very inadequately described when established by Gueranger. He separated the new genus from *Toucasia* because of the presence of one long, curved tooth *(B)* that extended beyond the edge of the shell of the upper, free, right valve. Later, in 1887, Douvillé[37] added that there was a jutting posterior myophore plate or ridge as in *Diceras;* that is to say, this plate is located low down in the shell and is *entirely free from the hinge plate* while in *Toucasia* the posterior myophore is attached to and a part of the hinge plate. This myophore is normal to the surface of the upper valve. Douvillé's statement that "exterieurement, les *Apricardia* ont exactement le meme forme que les *Toucasia*" is not entirely correct judging from illustrations of the described forms of the two genera. In *Toucasia* the upper valve is always operculate *(T. carinata* d'Orb.), at least during the early stages but may later develop symmetrically to the corresponding stage of the lower valve as in *T. lonsdalii* d'Orb. The latter stage only is seen in *Apricardia lævigata* d'Orb. and *A. asymmetrica*, n. sp. (Pl. VI, figs. 8, 9). In all other known forms the upper valve of *Apricardia* is a curved cone or is horn-shaped and never operculate *(A. chavesi*, n. sp. and *A. pironai* Boehm).

The surface may be either smooth or ornamented by fine growth lines or by fine lines parallel to the length of the shell.

The shell structure of the two valves is somewhat different. Both valves have two layers, a thin, homogenous outside layer and a thicker inner layer. The inner layer of the upper valve seems to be made up of a series of tubes or prisms longitudinally arranged giving somewhat the aspect of the Caprinidæ shell. In the lower valve some forms show a similar structure while others show a series of horizontal plates cut by a series of vertical ones as in the Radiolitidæ. The result is similar to the prismatic structure of the upper valve but the effect is a porous appearance. This porous structure is probably the compensating feature accompanying or means employed whereby the lower valve was able to so greatly surpass the upper valve in size.

No external ligament.

The origin of *Apricardia* is not clear. Douvillé suggests that it probably came from *Diceras* through *Toucasia*. However, in spite of the general similarity between these forms, the suggestion is not convincing for the reason that if *Diceras* once developed a flat right valve it is doubtful that the horn or cone-shaped form would ever be revived. This, however, is not impossible as many of the decadent races of ammonites assumed the loose and open coils of their early ancestors. The genus appeared in the Cenomanian and died out in the Turonian. The Turonian forms in the fauna under discussion were for the most part found above the *Radiolites* in the same limestone where fragments of their shells occur in great abundance. Fragments, however, are scattered through the *Radiolites* horizon.

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[37] Douvillé, H., Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 764, 1887.

6. **Apricardia chavesi** Palmer, new species

Plate VI, figures 6, 7

Plan of shell with valves joined, more or less circular; 2¾ inches in diameter, very inequivalve, left valve much the longer and larger, both valves horn-shaped, right valve but slightly coiled, left valve with about one turn; the two umbos touch and pass (Pl. VI, fig. 7), neither valve with keeled periphery nor external siphonal grooves; both valves have two shell layers: a thin, vitreous, outer and a thick inner that is longitudinally prismatic in structure. The latter structure shows as fine lines where exposed; lower valve with fine growth stages that are represented by fine radiating lines.

The juncture of the two valves on the anterior side is elevated forming a high ridge as in *A. tenuistriata* Futterer.

Holotype: No. 2159, Mus. Calif. Acad. Sci., from **5 miles north of Soyatlan de Adentro, Jalisco**; collected by Sr. Joaquin Chaves; Dec., 1921; Turonian, Cretaceous.

This form bears a close resemblance to *A. pironai* G. Boehm, from the Turonian of Santa Croce of northern Italy from which it can be distinguished by the umbos which are overlapping in *A. chavesi* and well separated in *A. pironai.*

This species also occurs in the limestone near Orizaba, Vera Cruz and in the limestone west of Ejutla, Oaxaca.

The species is named in honor of Joaquin Chaves, who found the type specimen.

7. **Apricardia asymmetrica** Palmer, new species

Plate VI, figures 8, 9

Lower valve (left), circular in outline; disc-shaped, rather flat, periphery somewhat keeled, closely coiled so that the opening or aperture passes the apex or umbo (Pl. VI, fig. 8). Attached by coiled umbo of left valve. Shell structure compact on the outside and porous on inside; porosity due to the horizontal and vertical plates as in *Radiolites*. These plates, however, are but slightly developed. The species is very inequivalve.

Upper valve resembling a segment of a cantaloupe (Pl. VI, figs. 8, 9). In no way does it resemble the lower valve. The upper flat area *(e)* forms a right angle with the convex part *(f)*. There are two distinct shell layers: a thin outer layer and a thicker inner layer composed of longitudinally prismatic structures. Dentition and myophores unknown.

Holotype: No. 2160, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

The external features of this species are well preserved in the form at hand. The two valves became partly disengaged and were buried while still held together by the ligament or adductor muscles which were subsequently fossilized. (Several examples of fossilized ligament and muscular tissue have been found in this particular horizon.) The crescent shape of the apertures of the two valves is unique.

This species strongly suggests *Requienia carantonensis* d'Orb. from the Cenomanian of France though it lacks the well developed keel seen in the early stages of that species. The hollow area of the concave side in the upper valve is also lacking in the European form.

Monopleuridæ Fischer[38]

"Shell very inequivalve, inverse, fixed by valve β; valve α free, operculate or slightly coiled, bearing two cardinal teeth of the same size, erect, separated by a socket; valves conical or spiral, supplied with a cardinal tooth between two cardinal sockets; ligament external; shell without canals." (Author's translation.)

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[38] Fischer, P., Manuel de Conchyliologie, p. 1052, 1887.

To the characters given by Fischer it may be added that the muscle scars are merely superficial and never elevated[39] and that neither valve possesses radial plates, i.e. they are not caniculate.

Monopleura Matheron 1842

The characters of the genus *Monopleura* have been summarized by Douvillé[40] as follows:

> "*Monopleura* is characterized by an almost equal development of teeth B and B′; the marginal tooth no longer presents the large and diverse forms so frequent in the Diceratidæ, it is on the contrary, conical and this difference in form appears in relation to the disposition of the ligament whose groove is almost normal to the plane of the opening, in place of being tangential.
>
> "Upon the lower or fixed valve, the medial tooth, *N*, is always well developed and more or less transverse: it is supported directly upon the internal edge of the shell in the straight forms and in the middle of the internal edge of the cardinal plate in the coiled forms *(M. varians)*.
>
> "The muscular impressions are superficial; they are sometimes merely thickened parts of the shell, but they are never borne on a jutting myophore." (Author's translation.)

The shell is very inequivalve. The lower valve is conical in shape and may be somewhat curved and even slightly coiled. It is smooth or ornamented with vertical ribs or by growth stages which appear as rings; there is one well developed vertical tooth between two deep pits; muscle scars entirely superficial; ligament internal, showing on the outside as a faint groove or not at all. Outer layer of shell made up of funnel plates similar to those of the Radiolitidæ. There are also a few traces of inconspicuous vertical radial plates that resemble the radiating structures that are seen in many pelecypods when the shell is eroded or split. The lack or rarity of these plates eliminates any possibility of the so-called vertical canals or accessory cavities. Upper valve flat, plain or ornamented with ribs that radiate from the ligament. Upper Neocomian to Santonian.

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[39] Douvillé, H., Sur quelques formes peu connues de la famille des Chamidés. Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 768, 1887.

[40] Douvillé, H., Sur quelques formes peu connues de la famille des Chamidés. Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 767, 1887.

8. **Monopleura salazari** Palmer, new species

Plate VII, figures 1-3

Lower valve conical; this may be modified by colonial habits; rather thick and heavy, about 4 inches high. Anterior side with 4 or 5 robust, horizontal growth stages (Pl. VII, fig. 2); these are the edges of thin funnel plates. Posterior side smooth. Ligament internal, showing externally as a shallow, fine line or absent. Shell composed of two layers (Pl. VII, fig. 3; *i* and *o*). Inner layer porcellaneous and showing no structure. Outer layer thicker and composed of (1) thin closely packed funnel plates and (2) closely spaced radial plates that show very faintly.

The body cavity occupies most of the interior; no septa in evidence. Myophores scarcely evident, simply thickened areas on shell wall (Pl. VII, fig. 3). Tooth sockets marginal, separated by thin, erect, plate-like tooth *N* (Pl. VII, fig. 3). No accessory cavities.

Upper valve somewhat convex (Pl. VII, fig. 1) without ornamentation; hinge plate and myophores known only by inference: anterior tooth much the larger, radial; posterior tooth, *B*, tangential.

This form is ascribed to the genus *Monopleura* on account of its general resemblance to that genus and the superficial nature of the two myophores of the lower valve. Any semblance of a platform or even thickened area of attachment is lacking. The well developed tooth of the lower valve is also Monopleurid. The muscle attachments of the upper valve alone are lacking to complete the generic requirements of *Monopleura*.

This form bears a striking superficial resemblance to *Polyconites verneuili* Bayle[41] but it lacks the thickened myophore areas.

The form is often colonial which results in compression as well as distortion of the shell.

Holotype: No. 2161, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; *paratype,* No. 410 (L.S.J.U. type collection); collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

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[41] di Stefano, Palaeontographica Italica, vol. IV (1899), 1898.

This well-defined, robust species is named in honor of Sr. Ing. Leopoldo Salazar-Salinas, the former Director of the Instituto Geologico of Mexico.

Tepeyacia Palmer, new genus

Shell cone-shaped, straight, flattened dorsally and ventrally, outer surface vertically corrugated. Shell wall composed of two layers: (1) a thick more or less homogeneous layer and (2) a thinner outer layer composed exclusively of funnel plates, *E* and *S* conspicuous, *E* much the larger and deeper; ligamental scar internal, appearing as an infolding of the outer layer of the shell into the inner. Hinge plate weak and thin and located entirely in the inner shell layer. The details of this structure are not known. Myophores superficial or inconspicuous, no trace of them exposed in the type specimen.

The animal was gregarious; note the attached fragment of a second individual (Pl. VII, fig. 4, x).

The external appearance of the shell suggests the Turonian genus *Distefanella* Parona. However, that genus is ascribed to the family Radiolitidæ to which the genus *Tepeyacia* cannot belong owing to the absence of vertical radial plates.

The thick inner shell layer, the fact that the outer layer is composed entirely of funnel plates, the weak hinge plate and myophore areas suggest the Monopleuridæ, to which this genus is provisionally ascribed in spite of the superficial resemblance to the Radiolitidæ.

Type of genus: *Tepeyacia corrugata,* n. sp.

9. **Tepeyacia corrugata** Palmer, new species

Plate VII, figures 4, 5

Shell small, about 3½ inches long, straight and erect; entire surface covered with very uniform, angled corrugations; decidedly flattened dorsally and ventrally. *E* and *S* deep and conspicuous. *E* a deep fold of the outer shell layer that extends through the inner layer to the body cavity; *S* shallower and not cutting through the inner layer. Ligament a distinct fold or ridge extending down the inner side of the outer layer and imbedded in the inner layer. The inner shell layer appears to be structureless except for very fine lines that run from the outer layer diagonally towards the body cavity.

The lower valve only is known.

Holotype: No. 2162, Mus. Calif. Acad. Sci., from **Tepeyac Mts., south of the city of Puebla, Puebla**; collected by R. H. Palmer, Jan., 1924; Turonian, Cretaceous.

The Turonian limestone is exposed in a low line of east and west lying hills a few kilometers south of the city of Puebla. The limestone is very pure and closely resembles that of the same formation at Huescalapa, Jalisco, on the western side of the highland.

This limestone contains very few fossils and these are very fragmental. The type specimen was obtained at about 500 feet below the top of the exposure. The species has also been found by the author in the limestone near Orizaba in the state of Vera Cruz.

Caprotinidæ

Externally this family does not differ from the Monopleuridæ. Internally the only distinguishing feature is the raised platform on which the posterior muscle scar is located.[42]

Horiopleura Paquier 1895

The type of the genus is *Horiopleura lamberti* Munier-Chalmas, originally described as a *Monopleura*. Later work by the same author disclosed that the muscular myophores were borne on well defined platforms which precluded the genus *Monopleura*. The name *Oriopleura* (later *Horiopleura*) was substituted for the name *Monopleura*.

Lower valve cone-shaped, usually slightly curved from its colonial habit; smooth or longitudinally ribbed; hinge well developed, the two muscle scars on well defined triangular platforms or benches; *ma, b, b'* and *N* in a straight line; *mp* at right angles to this line; *N* and *Da* are reduced to merely a marginal ridge; there are two low grooves, *E* and *S*, on the ventral side which appear as low rounded ridges on the interior. These are the siphonal areas.[43] Ligamental groove a rounded fluting on exterior but a deep sulcus in the inner layer (Pl. VIII, fig. 2).

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[42] Douvillé, H., Sur quelques formes peu connues de la famille des Chamidés. Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 776, 1887.

The shell is composed of two layers: the inner, thick dorsally but thinning on ventral side; the outer layer somewhat thicker, composed of thin funnel plates. The undulations in the edges of the latter cause the corrugations or ridges on the surface of the shell.

Upper valve operculate and rather flat, sometimes slightly swollen dorsally; two well defined teeth, *B′* somewhat the larger and radial, *B* tangential; *ma* on a conspicuous pendant platform that fits into a deep pit in lower valve.

This very inequivalve genus is distinguished from *Polyconites* by the posterior muscle scar of the lower valve. In *Polyconites* this is simply a thickened area in the shell while in *Horiopleura* it is an elevated platform whose surface is parallel to the shell opening and somewhat overhangs the body cavity.

It was formerly thought that *Horiopleura* occurred only in the Albien. Douvillé[44] stated: "The group *Caprotina, Caprina, Caprinula* characterize the upper Cenomanian exactly as *Horiopleura* characterizes the Albien." (Author's translation.) However, on page 652 he stated: "It is well understood that nothing prevents any of the species mentioned above from appearing at a somewhat earlier period nor from persisting into the Lower Cenomanian. It is for stratigraphers to fix the limits of each of these forms." (Author's translation.)

According to the same author,[45] *Horiopleura* probably branched from *Gyropleura* early in Albien times and early in the Cenomanian gave rise to the three branches, *Caprotina, Caprina* and *Caprinula.*

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[43] E, ingoing siphon; S, outgoing siphon.

[44] Douvillé, H., Sur quelques Rudistes du terrain crétacé inférieur des pyrénées. Bul. Soc Geol. Fr., 3rd Ser., vol. 17, p. 646, 1889.

[45] Douvillé, H., Sur quelques Rudistes du terrain crétacé inférieur des Pyrénées. Bul. Soc. Geol. Fr., 3rd Ser., vol. 17, p. 647, 1889.

10. **Horiopleura gregaria** Palmer, new species

Plate VIII, figures 1-5

Lower valve small, 1½ to 2 inches in length; straight or slightly curved, regularly and finely ribbed; ribs often obscured by contiguous members of the same colony; body cavity occupying approximately one-third of interior of shell; hinge plate and muscle scars conspicuous; the latter are peripheral, adjacent to the dental sockets and situated on large triangular buttresses below the plane of the opening of the shell and therefore do not appear in sections taken near the aperture; posterior myophore somewhat overhanging the body cavity. *N* square in outline. *Va*, *Vp* and *Da* very low, hence showing only in sections taken well below the aperture. *Da* thick and high; it functions as a tooth and as a guide to *B* and *B'*. Ligament a deep sulcus in inner shell layer and inconspicuous in outer layer. Location of *E* and *S* marked by folds. *E* is the deeper (Pl. VIII, fig. 3). Shell wall thick dorsally but thinning on ventral side; external layer somewhat thicker, composed of thin funnel plates, the undulations in the edges of these cause the corrugations in the surface of the shell.

Upper valve operculate, flat, often with a trace of swelling near dorsal edge. Two large teeth, the larger, *B'*, radial; *B* tangential, both of these are rather flat and extend along the under side of the valve wall as crescent shaped ridges. Posterior muscle scar located on a low pendant platform that projects well down into the lower valve (Pl. VIII, fig. 5). Above this is a small accessory cavity, *a*. There was but little rotation of the hinge, most of the opening and closing of the valves was accomplished by a more or less vertical movement of the upper valve.

Syntypes: Nos. 2163, 2164, and 2165, Mus. Calif. Acad. Sci., *paratypes,* Palmer collection, from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

This form grew in great abundance and probably formed extensive colonies not unlike Balanus of the present day.

The two folds *E* and *S*, with *E* the deeper, the structure of the shell and the corrugated surface suggest *Tepeyacia corrugata,* though the stratigraphic position of the latter, high up in the Turonian, indicates that the kinship is not close.

February 29, 1928.

Chaperia Munier-Chalmas 1873

Munier-Chalmas[46] described this genus as follows:

"Diostracum (cast) very inequivalve, sinistral, ornamented by longitudinal ribs. Valve α, free, operculate and in general a little convex. Beak none or very rudimentary, sinistrogyrate. Two inequal cardinal teeth; the anterior is simple, subcircular or polygonal and slightly elevated; the posterior is long and split, as in *Hippurites*. Anterior adductor muscle supported by a large projecting plate, that rises from the base of the anterior cardinal tooth. Posterior muscle is inserted upon a small and slightly prominent surface, presenting towards the base of the posterior cardinal tooth a small, shallow circular depression. The ligament is inserted upon a spur that is but little developed. It is formed by a fold of the shell and is situated upon the posterior cardinal side a little below the beak

"Valve β fixed, conical, straight or arched and not long. The pallial edge is continuous and circular. It presents, a little below the external edge, a thickened circular area that follows the contours of the pallial region. This supports the edge of the other valve which is smaller and consequently more or less re-entrant The anterior cardinal tooth is small and bent. The posterior cardinal cavity is small, deep and included between the ligamental cavity and the cavity of the posterior adductor muscle Anterior cardinal cavity is quite deep and formed by a prolongation or fold of the anterior edge of the cardinal tooth. Posterior adductor muscle is inserted upon a very oblique plate. It is joined to the posterior edge of the cardinal tooth in such a way as to form quite a deep cavity, the most anterior portion of which is destined to house the posterior edge of the bifid cardinal tooth of the opposite valve The ligamental spur is small and situated in a deep cavity that extends to the summit of the valve. It has the same general disposition as the *Hippurites.*

"Type: *Caprotina costata* d'Orb.

" . . it *(Chaperia)* is easily distinguished from the *Caprotinidæ* by the valve α which is operculate and by all means by the manner of the insertion of the posterior muscle, as can be seen in the figures of d'Orbigny, which present the internal characters of the upper valve." (Author's translation.)

11. **Chaperia socialis** Palmer, new species

Plate VIII, figure 6

Lower valve conical, somewhat contorted, surface covered with angular longitudinal ribs; one siphonal groove only appears on the ventral side.

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[46] Munier-Chalmas, Bul. Soc. Geol. Fr., 3rd Ser., vol. 10, pp. 493-4, 1882.

Upper valve operculate, slightly convex, smooth, resting within the opening of the lower valve upon a marginal flange of the latter.

Individuals of this species grew in colonies not unlike *Balanus* of the present time. This explains the contorted forms of individuals.

Holotype: No. 2166, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Dec., 1921; Cenomanian, Cretaceous.

This form closely resembles *Horiopleura gregaria* but is distinguished by the convex upper valve and the lack of any trace of an external ligamental groove.

This species is very common in the Jalisco locality.

Baryconites Palmer, new genus

Lower valve heavy and robust, conical, smooth or longitudinally ribbed. Shell wall composed of two layers: (1) inner, very thick and coarse, composed of thin funnel plates which make an angle of about 45° with the surface; and (2) outer, thin, also composed of extremely thin funnel plates that have the same attitude as those of the inner layer. On the ventral side of the shell there are two wide, flat, vertical siphonal areas separated by a narrow ridge; hinge plate very large and heavy; anterior muscle scar large and triangular, posterior muscle scar large, elongate and narrow; two radial dental sockets, *b′* being much the larger; *N* radial and erect; body cavity comparatively small, septate; ligament for the most part internal.

The clearly marked characteristics of this shell prevent its being ascribed to any known genus. The nearest related genera are *Polyconites* and *Horiopleura.* Its large and salient muscle scars set it off from the former genus while the long linear posterior muscle scar *mp* between *b* and the shell wall excludes it from the genus *Horiopleura.*

The genus is described from the lower valve only

Type of the genus: *Baryconites multilineatus,* n. sp.

12. **Baryconites multilineatus** Palmer, new species

Plate VIII, figure 7

Lower valve cone-shaped, heavy and coarse; 5 inches in diameter, regularly striated with small vertical ribs numbering approximately 16 to the inch; ligament showing as a low sinus on the surface; *E* and *S* wide, finely striated; *b'* large, radial, deep and triangular in outline with the base towards the center; *b* near the ligament, small and somewhat round in outline; few small vertical holes in both shell layers, those of the inner layer peripheral and showing a tendency to disappear with age. For example, there are six holes on the lower end and two on the upper; the vertical ribs or corrugations are due to undulations or frills on the upper edge of the thin plates of the outer layer.

Upper valve unknown.

Holotype: No. 2167, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

The undulations in the upper edge of the thin layers were caused by the frills of the secreting mantle of the living animal and where they were interfered with by oysters or other sessile organisms the undulations are not regular and suggest the edges of the leaves of an untrimmed book.

On the dorsal area there are a few irregularly spaced vertical radiating plates suggesting kinship to the Radiolitidæ.

Polyconites (Bayle)

This genus is similar to *Monopleura* except that in the lower valve *mp* is somewhat raised and opposite to the flat pendant myophore of the upper valve. The anterior muscle scar is superficial.

Douvillé[47] thus described this genus:

> "Lower valve as in *Monopleura,* the two muscle impressions borne simply on the thickened areas of the shell and the posterior impression presents neither a ridge or a raised platform; only the ligamentary cavity

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[47] Douvillé, H., Sur quelques Rudistes du terrain crétacé inférieur des Pyrénées. Bul. Soc. Geol. Fr., 3rd Ser., vol. 17, p. 638, 1889.

is internal. Upper valve presents a flat posterior muscle scar. It is thin and separated from the internal surface of the valve by a large accessory cavity." (Author's translation.)

Polyconites has not been reported from Mexico though undescribed forms from San Juan Raya in Puebla are apparently referable to this genus.

Caprinidæ d'Orbigny

The family is characterized by the series of vertical radiating plates in the middle layer of the shell wall. These plates usually bifurcate and the branches join, producing a series of vertical tubes which are usually referred to as canals. These may be in either or both valves, depending on the genus. The outside edges of these plates also thicken and anchylose, forming the outside shell layer (Pl. XI, fig. 5.)

Very inequivalve. The lower valve is elongated and curved (Pl IX, fig. 2) or angled (Pl. IX, fig. 3). The upper valve is short and horn-shaped and may be coiled in one plane or may be slightly spiral in which case the spire is usually directed toward the anterior as in the forms under discussion, or towards the posterior side, as in *Caprina adversa* d'Orb. and many species of *Schiosia.* The coil varies from ¼ to 1¼ turns. Only in rare cases is the upper valve the larger, e.g. an occasional specimen of *Coralliochama orcutti* White or *Caprina adversa* d'Orb. The cross-sections of practically all the forms at hand are more or less quadrilateral or trapezoidal.

The principal anatomical features are illustrated in Pl. X, fig. 1 and Pl. XI, fig. 5.

Shell layers, radiating plates and "canals" or tubes: The shell wall of all forms herein described is composed of three parts: a thin, inner layer; a thick middle layer, in which the vertical plates are located and a thin outside layer. In some species the layers are distinct. In others they appear to be simply different parts of the same thing, the inner layer being the basal structure from which the vertical radiating plates extend and the outside layer being merely the thickened outer edges of the plates and their branches that have coalesced (Pl. XI, fig. 5).

When the surface of the shell is worn the anchylosed edges of the radiating plates are removed and the free edges are exposed giving the surface a striated appearance.

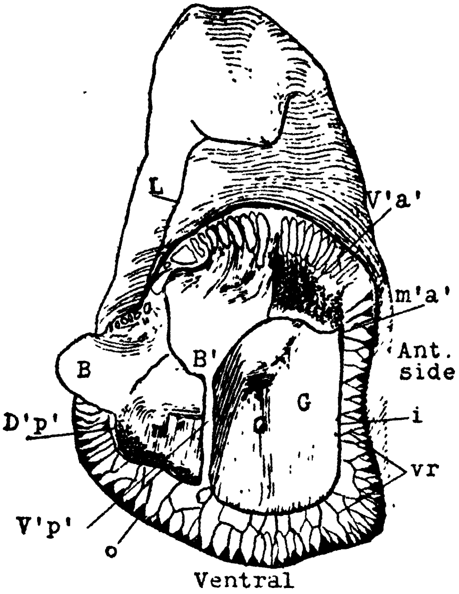

Fig. 6. *Caprinuloidea perfecta* n. sp.

B'.	Anterior tooth.
B.	Posterior tooth.
G.	Body cavity.
m'.	Cavity accessory to *n*.
L.	Ligament groove.
V'a'.	Ventral anterior keel of *B'*.
V'p'	Ventral posterior keel of *B'*.
D'p'.	Dorsal posterior keel of *B*.
m'a'.	Anterior myophore.
i.	Inner shell layer.
vr.	Vertical radial plates. These form the "canals" and with them constitute the middle shell layer.
o.	Enlarged outer edges which fuse and form the outer shell layer.

Note that the beak turns to right of ligament.

The plates may assume several forms with respect to branching. If they do not branch there is but a single row of tubes (text fig. 6). If they branch once there are two rows of tubes; twice, there are three rows and so on. In other forms the branching and uniting of adjacent plates has been so complex that the result is a series of tubes imbedded in a reticulated matrix (Pl. X, fig. 2). Between these two extremes there is every degree of intergrade. The spaces between the main plates are much wider than those between the branches near the periphery, hence the tubes are much larger. These have been called "accessory cavities" by confusing them with cavities of a different origin in other genera. Douvillé[48] stated: "These canals are formed by folds of the internal plates and seem to us homologous to the accessory cavities of *Caprotina.*" (Author's translation). Later, however, the same writer pointed out that in *Cardium edule* there are certain clear analogies between the nerves of the pallium and the radiating plates of that animal. He therefore concluded[49] that: "The network formed by the radiating plates in the Rudistids corresponds to the ramifications of nerves of the marginal region of the mantle." (Author's translation.) This interpretation may be inferred from the fine, root-like processes (Pl. XII, fig. 2, k) that extend from the vertical plates and their branches in *Caprinuloidea bisulcata.*

In the fossil state the canals or spaces between the radiating plates are usually filled with calcite, though many are filled with sand and silt showing that they were hollow during the life of the animal. Some species show small septa or tabulæ in the larger interior tubes; these are always concave (Pl XIV, fig. 5).

In many of the better cross-sections a thin line is seen to run down the middle of the plate (Pl. XII, fig. 2, k). This suggests that each plate is really composed of two parts and the line is the edge of the plane of union.

The function of these plates was apparently to give the greatest strength to the shell with the material at hand. In no place have any connections been observed between the enclosed tubes and the outside or the body cavity. However, they may function as true canals for reasons pointed out in the remarks under the genus *Caprinuloidea.*

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[48] Douvillé, H., Sur quelques formes peu connues de la famille des Chamidés. Bul. Soc. Geol. Fr., 3rd Ser., vol. 15, p. 780, 1887.

[49] Douvillé, H., Études sur les Rudistes. Bul. Soc. Geol. Fr., 3rd Ser., vol. 26, p. 157, 1898.

Ligament in the twelve species at hand is internal and its position always marked on the surface by a crease. The form of the cross-section resembles a boot with the toe pointing toward the anterior. The ligament is always on the concave side of the upper valve but may be either on the concave or convex side of the lower valve. In the latter case the engaged valves have the shape of an elongated S.

Internal structure, lower valve: The large prominent post-like tooth, *N*, is situated in the dorsal area under or anterior to the ligament. It is the principal structure of the lower valve and upon it nearly all the other structures depend. It is quadrilateral in cross-section and from each corner there radiates a keel or flange: *Va, Vp, Da,* and *Dp.* These keels join *N* to the shell wall. Their function is to divide the internal cavity into four smaller cavities, namely: *G,* the body cavity, *b* and *b′,* the dental sockets and *m,* whose function is not definitely known. *Vp* is always curved in cross-section with the concave side towards *G.* This results in *G* being rounded in outline.

The keel or partition *Dp* is a ridge that runs down the posterior side of *N* and across the base and up the shell wall. It seems to serve more as a guide holding *B* in a vertical groove than as a partition. It shows as a complete partition only in sections taken well below the top of the shell (Pl. X, fig. 1). However, the ridge *Dp* on *N* and the opposing one on the shell wall show in all sections. Douvillé recognized this septum and the cavity *m* which it forms. This he called *b+Omp′*.[50]

> "The large cavity which receives both the posterior tooth *B* and the muscle impression which accompanies it, does not present, in our sections, any transverse partition; but it is possible that it exists at a greater depth; this cavity is opposite to the cavity *n n′* of the other valve." (Author's translation.)

The function of this cavity *m* as well as that of the opposing one *m′* in the upper valve is not known. From the fact that *mp* occupies a part of *m* in the Caprinidæ and all of *m* in the

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[50] Douvillé, H., Sur quelques Rudistes americains. Bul. Soc. Geol. Fr., 3rd Ser., vol. 28, p. 208, 1900.

Monopleuridæ it is not unreasonable to suppose that *m* was formerly a much larger *mp* of which the present one is but a remnant.

With the exception of *Dp* all the keels or partitions reach the plane of the opening of the valves and show in all cross-sections.

The function of *N* is to support the three keels and not to engage with any structures. Only the keel, *Da* functions in this manner.

The posterior and the anterior myophores, *mp* and *ma,* are the areas where the adductor muscles are attached. These are always located near the peripheral ends of *Va* and *Vp* in the lower valve and *V'a'* and *V'p'* in the upper valve (Pl. XI, fig. 6). These are usually long and linear in cross-section. In *Caprinuloidea bisulcata,* n. sp. the myophores show a tendency to become thicker and shorter in cross-section.

The body cavity, *G,* is always circular in outline. In it were lodged the vital parts of the animal. It is very large in most species but relatively small in *Caprinuloidea multitubifera,* n. sp. (Pl. X, fig. 2.) *G* may or may not be septate.

Da is the large dorsal anterior keel of *N.* Its function is three-fold: (1) It is the main support of *N;* (2) it separates *b* from *b';* and (3) it is the effective part of the hinge plate with reference to the teeth *B* and *B'* as these straddle *Da* when the valves engage. The meshing of the teeth of the two valves prevented rotation and kept the homologous parts in opposition like the teeth of a modern bivalve. Thus far no forms have been found where margins of the valves are crenulated to accomplish the same end as in *Arca, Cardium, Tridacna* or the fluted oysters.

Internal structure, upper valve: The general form of the upper valve has been given above. Regardless of whether the lower valve is dorsally or ventrally concave, the upper valve is always dorsally concave. All forms in the fauna under discussion, expect *Planocaprina trapezoides,* n. sp. have two subequal teeth with *B'* somewhat the larger. *B* is tangential and *B'* is set more or less radially. The inner side of each tooth is provided with a flange or keel that extends to the shell wall and divides the interior into four parts which, together with the keels, are opposite to corresponding parts in the lower valve.

Between $V'p'$ and $D'p'$ is the large cavity m'. It has long been noted that N (more properly Da) occupied only n, the dorsal part of this cavity or merely the part between the two teeth and the term n' has heretofore been applied to the rest of the cavity which is here called m'. The function of this cavity was no doubt analogous to that of m in the lower valve.

Several of the forms are attached to others, i.e. the animals were colonial or gregarious. As in the case of oysters or Chamas there was no selection of place of attachment with the result that the animals grew in more or less promiscuous clusters. This is also indicated by the presence of several species attached to older and larger forms. The place of attachment and the proximity of other objects largely determined whether the lower valve took a straight or a curved form. If the animal's growth was interfered with on the dorsal side the shell became concave dorsally (Pl. IX, fig. 2) and vice versa (Pl. XI, fig. 2).

Range: It was formerly thought that the Caprinidæ did not appear until the Cenomanian period.[51] Other references of the same import occur in the literature of the early 90's. Later Paquier found a few generalized types in the Urgonian.[52] However, the great deployment of the group occurred during the Cenomanian. This took the form of a wide dispersal to practically all tropical shores together with the development of a large number of species.

The Caprinidæ reached their culmination in the Cenomanian and but few forms lived on in the Turonian and practically none survived the close of that period.

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[51] Douvillé, H , Sur quelques Rudistes du terrain crétacé inférieur des Pyrénées. Bul Soc. Geol. Fr., 3rd Ser , vol 17, p. 646, 1889.

Author's translation The group *Caprotina, Caprina, Caprinula* is found, then, to characterize the upper Cenomanian

[52] Paquier, Sur quelques Rudistes nouveaux de l'Urgonien. Comptes Rendus de L'Academie des Sciences, vol. 122, pp. 1223, 1434, 1896.

Caprinuloidea Palmer, new genus

The lower valve is usually long and curved with the anterior side flat, though it may be short, cone-shaped and straight. The upper valve is always horn-shaped, may be bent or loosely coiled. The dorsal side is always concave in the upper valve but may be convex in the lower. This is probably governed by the gregarious nature of the animals and by the nature ot the places where attached. The surface may be smooth, transversely ribbed or longitudinally striated. Plate IX shows the essential features of the external form.

As in *Caprinula*, both valves possess the vertical radiating plates and resulting canals, the plates bifurcate two or three times, the bifurcations usually being somewhat more complicated around the anterior and posterior areas. Branches from contiguous plates anchylose producing round and polygonal canals. The inner canals may be septate or not but the outer are always aseptate.

The internal parts illustrated in Pl. X, figs. 1, 2, are present in all forms. *B* and *B'* are subequal and well developed. *B'* somewhat the larger. They are usually somewhat curved parallel to the general course of the shell. *N* is large, straight and erect.

In all the species at hand the upper valve coils towards the anterior side as in the so-called inverse types (Pl. VIII, fig. 8).

The ligament lies in a deep fold which is marked by a groove on the dorsal surface.

This genus differs from *Caprinula* and *Schiosia* by the lack of the large accessory cavities that appear in those genera in the posterior areas of both valves.[53]

The genus is represented in the deposits at Soyatlan de Adentro, Jalisco, by six species and abundant individuals.

Type of the genus: *Caprinuloidea perfecta*, n. sp.

13. **Caprinuloidea perfecta** Palmer, new species

Plate VIII, figure 8; plate IX, figures 1, 2; text figure 6

Shell large, robust and smooth; lower valve elongated and slightly spiral; subquadrilateral in section with the anterior side flat; this forms a distinct angle along the ventral side. *N* and *Da* large and coarse; several vertical tubes give these a porous structure. This feature is probably confined to the rapidly growing forms. Shell thick, with extensive bifurcating of the vertical plates. The body cavity is septate in both valves.

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[53] Douvillé, H., Études sur les Caprines. Bul. Soc. Geol. Fr., 3rd Ser., vol. 16, p. 705, Pls. 22, 23, 1888.

Upper valve of one or more coils, distinctly spiral. Teeth large and coarse. *B'* rather triangular in outline with groove on dorsal side. *B* oval and somewhat smaller. Vertical plates twice bifurcating on ventral side and not branching on dorsal side, resulting in long, narrow, radial canals. Small shallow pits above *V'a'* and *D'p'*.

Holotype: No. 2168, Mus. Calif. Acad. Sci., both valves; from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

The specimen shown in Plate IX was fractured during the life of the animal. It subsequently healed though the fractured surfaces were offset. This episode suggests either that the shell was imbedded in shore material or that the parts were held together by the ligament. Had this not been the case, the parts of the shell would have been separated beyond all possibility of therapeutical repair. It also definitely suggsets that the "canals" between the vertical plates were real canals and functioned as conduits through which passed appendages from the mantle of the animal. Otherwise it is difficult to explain the healing except at or near the mouth of the shell.

14. **Caprinuloidea perfecta gracilis** Palmer, new subspecies

Plate IX, figure 3; plate X, figure 1

This form in every way resembles *C. perfecta* except that it is much slimmer in proportion to its length and is usually angular longitudinally.

Holotype: No. 2169, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

The modification is very common at the Jalisco locality. Its slimness is not due to age because individuals much longer than other species of the genus are usually about one-half the diameter of the latter.

15. **Caprinuloidea multitubifera** Palmer, new species

Plate X, figure 2

Shell thick and robust, both valves quadrilateral in cross-section, ventral side flat or even slightly concave; lower valve straight or slightly curved, upper valve horn-shaped and slightly curved. Canals in both valves round.

Upper valve with teeth, *B* and *B'*, large; *G* very small; *ma* and *mp* both large, crescent shaped and thick, not linear as in most of the other species of this genus. Shell wall thick except on dorsal side; radiating plates and their branches reduced to a network in cross-section, only at the outer margin does the real nature of the plates appear; *V'p'* is very short owing to the large size of the teeth; *n* is large; the cavity *m'* is very small.

Lower valve similar in cross-section to upper valve; bifurcations of the radial plates less complex.

Holotype: No. 2170, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

The most noticeable features that a cross-section of this species affords are the extremely large teeth and the resulting reduction in the size of the cavities *G* and *m*. The numerous, round and irregularly spaced canals are also noteworthy features. The canal pattern very closely resembles that of *Mitrocaprina vidali* Douvillé.[54] However, the large teeth and small body cavity of the new species exclude it from the genus *Mitrocaprina*.

The canal or radial plate pattern of *Sphærucaprina felixi* Boehm,[55] from Cerro Escamela near Orizaba, Vera Cruz, very closely resembles that of *Caprinuloidea multitubifera* n. sp. Boehm described *S. felixi* from a section only which he supposed was the upper valve. It is open to question whether or not it is ascribed to the proper genus. The genus *Sphærucaprina* is without the radiating plates and canals in the lower valve while the upper valve is similar to that of *Caprina*. Hence the lower valve is necessary to the proper determination of the genus. It is probable that *S. felixi* Boehm is in fact *Coalcomana*. This seems the more probable in view of the fact that there is a large amount of marble from Cerro Escamela used for decorative purposes in Mexico, particularly in Orizaba and Mexico City and polished surfaces of this material show abundant sections of Caprinidæ with scarcely one without radiating plates and canals, the inference being that the genus *Sphærucaprina* was but sparsely represented in this part of Mexico.

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[54] Douvillé, H., Sur quelques Rudistes à canaux. Bul. Soc. Geol. Fr., 4th Ser., vol. 4, p. 519, 1904.

[55] Boehm, G., Ueber Caprinidenkalke aus Mexico. Zeit d. d. Geol. Gesell., vol. 50, p. 329, 1898.

Nerinea, as well as *Coalcomana*, is also found in the limestone at Escamela as at Soyatlan; Boehm[56] believes the former to be upper Cenomanian.

16. **Caprinuloidea septata** Palmer, new species

Plate IX, figure 4; plate X, figure 3; plate XI, figure 1

This form is similar to *Caprinuloidea perfecta* except that in the lower valve *G*, *b* and *b'* and the inner row of vertical canals are septate. The vertical plates do not bifurcate more than once except in the vicinity of *Va*, hence there is but one or two rows of canals (Pl. XI, fig. 1).

Holotype: No. 2171, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

In the larger specimen there is much spongy tissue in *N*, *Va* and *Da*. This is suggestive of the genus *Rousselia*[57] but is, however, the only structure the forms have in common.

17. **Caprinuloidea costata** Palmer, new species

Plate XI, figures 2, 3, 4, 5

This species is characterized by transverse, somewhat imbricating ribs that cover the surface of both valves. These ribs represent growth stages. Both valves are more nearly round in outline than in other species.

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[56] Boehm, G., Ueber Caprinidenkalke aus Mexico. Zeit. d. d. geol. Gesell., vol. 50, p 382, 1898.

[57] Douvillé, H., Sur un nouveau genre de rudistes *(Rousselia guilhoti)*. Bul. Soc. Geol. Fr., 3rd Ser., vol. 26, p. 151, 1898.

Upper valve coiled nearly in one plain but not so tightly coiled as *Caprinuloidea perfecta.* A well defined inner row of peripheral canals is present between the unbranched radial plates. The plates regularly branch three times on the ventral side and once or not at all on the dorsal side. Both myophores are long and linear.

Lower valve elongated, straight or curved. The transverse ribs are slightly undulating except on the dorsal side where they turn upward and form an angle at the ligamental groove. This is particularly noticeable on the posterior side (Pl. XI, fig. 3). The body cavity is round, large and not septate. *N* and *Da* often show vertical tubes, i.e. are somewhat spongy. The myophores are for the most part much shorter in cross-section than those of the upper valve. This suggests that the adductor muscles were somewhat like an inverted triangle in form. One specimen shows a thin projecting shelf for the anterior myophore. The bifurcating of the vertical plates is somewhat less complicated than in the upper valve.

Syntypes: Nos. 2172, 2173, Mus. Calif. Acad. Sci., both valves; from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

The plan of the bifurcating plates is similar to that of *Caprina ramosa* Boehm.[58] However, in that species Boehm indicates an accessory cavity between the dental area and the shell wall. This is absent in the species at hand. As the description of *C. ramosa* is confined to a cross-section in which nearly one-half of the interior was replaced by calcite and the exterior of the shell was not described, it does not seem wise to use Boehm's name for this species.

The ribbed surface, the angle that the ribs make with the ligamental groove and the more or less rectangular cross-section of the shell suggests *Cornucaprina carinata* Boehm.[59] The simple radiating plates of that species, however, eliminate the present species from that genus.

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[58] Boehm, G., Ueber Caprinidenkalke aus Mexico. Zeit. d. d. geol. Gesell., vol. 50, p. 327, 1898.

[59] Futterer, K., Die oberen Kreidebildungen der Umgebung des Lago di Santa Croce in den Venetianer Alpen. Palaeontologische Abhandlungen von Dames und Kayser, vol. 6, n. s. 2, p. 87, 1892-96.

18. **Caprinuloidea bisulcata** Palmer, new species

Plate XII, figures 1, 2

Lower valve straight or slightly twisted, resembling *C. costata* in general appearance; large, low, dorsal groove or sinus anterior to ligamental groove. Compared with *C. costata* the shell is somewhat thicker, the design of the radiating plates is somewhat more complicated and the body cavity is smaller. Posterior myophore, *mp*, smaller than *ma* (about ⅓ in specimen) and located in acute angle of *Vp* and body wall and extending along the interior of *m; ma* large, located between *Va* and wall, ventral end large, oval in cross-section, dorsal end extending as thick spur between *b′* and shell wall. No septa in body cavity and probably none in canals.

Upper valve unknown.

Holotype: No. 2174, Mus. Calif. Acad. Sci., from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Aug., 1922; Cenomanian, Cretaceous.

This species is readily distinguished from *C. costata* by the two deep dorsal grooves and the large anterior myophore, *ma,* of the lower valve.

Planocaprina Palmer, new genus

General form that of the Caprinidæ except that the upper valve is somewhat longer than is usual in that family. Both valves with one row of subequal, rounded or pyriform canals, i.e. the radial plates are simple and unbranched; cross-section more or less trapezoidal.

Lower valve straight or curved; upper valve either loosely or tightly coiled. Animal attached by tip of lower valve. Cavities *G* and *m* about equal in size. *B′* large and curved; *B* lacking or rudimentary.

This genus belongs to the group of Caprinidæ that has canals in both valves. Its simple vertical plate arrangement and single row of canals and the well developed tooth *B′* suggest *Cornucaprina* but it is distinguished from that genus by its lack of accessory cavities, the coiling of the upper valves towards the anterior and by the extreme marginal location of *B′*.

Type of genus: *Planocaprina trapezoides* n. sp.

19. **Planocaprina trapezoides** Palmer, new species

Text figures 7, 8

Both valves with one row of aseptate canals in shell wall; ligament external; valves rather long and narrow; dorsal, ventral and anterior sides make a right-angled trapezoid; ventral side very wide; posterior side somewhat concave; posterior and ventral sides prolonged, forming a rounded keel. Shell wall with apparently but one layer, though there is possibly a thin superficial layer.

The radiating plates that form the tubes do not branch, i.e. they form but one row of tubes, except in the angle of the ventral and anterior sides where there is a trace of some branching and anchylosing of adjacent plates which results in a second or third row of tubes. The outer ends of the radial plates thicken until the edges touch and then anchylose forming what may be termed for convenience, the outer layer of the shell, which is very thin. Body cavity large.

Lower valve more or less curved. The specimen described is concave on the posterior side; *b'* rather small; *b* reduced to a small notch in *N; m* large; *ma* and *mp* reduced to two small thickened areas at end of *Va* and of *Vp; N* medium sized and marginal; *Va* and *Vp* very thin; *Dp* very short and thick.

Upper valve curved in two planes: it rises more or less in a vertical plane and curves toward the dorsal side, i.e. making the dorsal side concave, until it reaches a horizontal plane and then curves counter-clockwise (i.e. towards the anterior) and continues one turn more or less, remaining in the horizontal plane. Coil loose and open. *B'* is large and porous, marginal, curves outward toward the dorsal side and has a wide, shallow pit on the dorsal side; *B* reduced to thickened area in which is imbedded the ligament; *m'* equal in size to *G; n* is deep and narrow and curves around *B'* reaching nearly to the margin. Myophores small and situated as in lower valve, *ma* elevated above the margin of the shell opening, hence entering the lower valve when the valves are joined. Upper anterior edge of shell opening rounded suggesting that the upper valve rotated as in living bivalves.

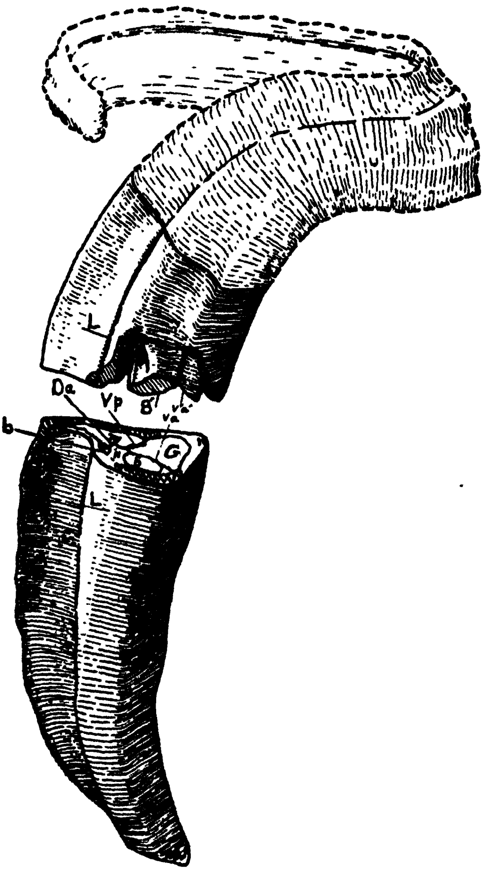

Fig. 7. *Planocaprina trapezoides* n. sp. x ½.
The two valves have the same relative position as during the life of the animal.
For explanation of symbols see Pl. XI, fig. 5.

Syntypes: Nos. 2175, 2176, Mus. Calif. Acad. Sci., both valves; from **Soyatlan de Adentro, Jalisco**; collected by R. H. Palmer; Dec., 1921; Cenomanian, Cretaceous.

This oddly appearing form is characterized by the trapezoidal cross-section and the curiously curved upper valve. It is common at the type locality.

Due to the thinness of the shell and of the partitions, the body cavity, *m*, and the dental cavities are usually crushed.

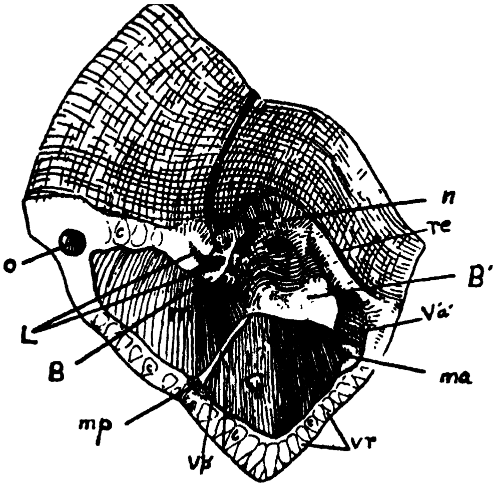

Fig. 8. *Planocaprina trapezoides* n. sp.
Details of upper valve, natural size.
B. Rudimentary posterior tooth.
d. Wide narrow shallow groove in anterior tooth.
re. Rounded anterior edge of upper valve. (See p. 65).
vr. Vertical radial plates. These do not branch, hence form but one row of canals.
c. Canals.
o. Accessory cavity.
Note trapezoidal section of shell.
For explanation of other symbols see Pl. X, fig. 1.

The plan of the radiating plates and the included canals is practically identical with that of *Caprina* cf. *adversa* d'Orb. from Escamela in the state of Vera Cruz, Mexico, as described and figured by Boehm.[60] The flattened dorsal, ventral and anterior sides are also similar to that species. However, in the present form, the great development of *B'*, its marginal position, and the resulting total lack of accessory cavities between it and the shell wall, the disappearance of *B*, the presence of canals in both valves, not only remove it from the species above mentioned but also from the genus *Caprina*.

The small accessory cavity shown in the keel of the upper valve does not extend through the specimen.

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[60] Boehm, G., Ueber Caprinidenkalke aus Mexico. Zeit. d. d. geol. Gesell., vol. 50, p. 326, 1898.

A portion of the rock to which the shell was fixed is still attached to the lower valve.

Coalcomana Harris & Hodson 1922

This genus has been inadequately described by Harris & Hodson[61] from sections and descriptions of specimens from Coalcoman, Guerrero, published by Boehm and by Douvillé. Boehm's material consisted of only a badly preserved section of an upper valve which he ascribed to the genus *Caprina.* Douvillé later obtained specimens of both valves and finding canals in both ascribed it to *Schiosia.* Harris & Hodson, using the published data of these two authors pointed out[62] that: "The marginal canals in *Schiosia* are simply radial, but in the Mexican form, pyriform and bifurcating, . . ." and ascribed the form to a new genus which they called *Coalcomana.*

It is probable that the authors did not intend to apply the term "bifurcating" to the canals but to the vertical radiating plates (Pl. XII, fig. 4) as the canals are never bifurcating. In *Schiosia* the radiating plates do not branch with the result that there is but one row or series of canals in the shell wall. In the form at hand the bifurcation of the vertical plates produces as many rows of pyriform canals as there are bifurcations. *Coalcomana* differs from *Caprinula* and also from *Schiosia,* in both of which the two valves are caniculate, by the absence of accessory cavities in the shell wall. It differs from *Caprinuloidea* to which it approaches the closest by the branches of the vertical radial canals not joining to produce the polygonal or rounded canals except in the dorsal and anterior areas. Elsewhere these plates divide and each branch continues to the edge of the shell as in *Plagioptychus,* producing different ranks or rows of pyriform channels or canals which, like the plates, extend to the outer surface of the shell (Pl. XII, fig. 4).

The external form and main internal features of *Coalcomana* are the same as those of *Caprinuloidea.*

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[61] Harris & Hodson, Paleontographica Americana, vol. I, no. 3, p. 14, 1922.

[62] loc. cit. p 14.

20. **Coalcomana ramosa** (G. Boehm)

Plate XII, figures 3, 4

Caprina ramosa Boehm, Zeit. d. d. geol. Gesell Vol. 50, p. 327, 1898.
Schiosia ramosa (Boehm), Douvillé, Bul. Soc. Geol. Fr., 3rd Ser., vol. 28, p. 206, 1900.
Coalcomana ramosa (Boehm), Harris & Hodson, Paleontographica Americana, vol. 1, No. 3, p. 14, 1922.

Lower valve as in *Caprinuloidea;* large, rounded canals in wall in the area exterior to *ma* and *b';* elsewhere the plan of the plates and canals is similar to that of *Plagioptychus,* i.e. the branches of the plates do not join but each extends to the surface of the shell; *dp* well developed, *b'* much larger than *b;* body cavity large; *ma* and *mp* very thin and linear in cross-section. From the Cenomanian at Soyatlan de Adentro, Jalisco.

Schiosia G. Boehm[63] 1892

"Shell thick, very inequivalve, the larger left valve spiral, greatly elongated, drawn out into an open or closed spire, the main whorl directed towards the rear. The smaller right valve is caputiform with a close strongly curved back lying close to the hinge plate. Outer shell layer very thin covered with radial ribs; the latter are crossed by fine concentric rays. Inner layer porcellaneous, strongly developed. The body cavity is very small. The ligament furrow runs outside the umbo. It folds inward and makes a well developed internal ligament groove. Behind the body cavity, the left valve shows a second accessory cavity separated from it by a thin partition which extends to the vicinity of the hinge wall and here makes a socket for the tooth of the smaller right valve. The inner layer of each shell is pierced by parallel canals which are divided into two groups. The first was limited by the mantle edge to the anterior area and shows exclusively radial and never polygonal canals. The second group is developed in the hinge area and includes irregular, large and small, round oval or polygonal canals. On the weathered surface, the inner row of radial furrows only appears. Hinge probably developed as in *Caprinula.*

"Type: *Schiosia schiosensis,* n. sec., n. sp.

"Remarks. The above characterized *Schiosia* is, at all events, very close to *Caprinula.* There as here the marginal canals are developed in both valves and also the hinges do not show any great differences. On the other hand there are not only radial canals in *Caprinula,* as far as I know, but also polygonal marginal canals are developed; in *Schiosia* only the former. . . . The simple and complex canal system at all events stand in direct genetic relationship so I have preferred to consider *Schiosia* not as a new genus but rather only a section of *Caprinula.*" (Author's translation.)

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[63] Boehm, G., Freiburg Naturforschende Gesellschaft, vol 6-7, p. 144, 1891-3.

Schiosia is very similar to the genus *Coalcomana.* In fact, the type of the latter was described as a *Schiosia.* In the Maltrata limestone at Orizaba, Vera Cruz occur abundant forms belonging to *Schiosia* or to a very closely related genus.

Caprinula d'Orbigny 1847

D'Orbigny made *Caprina boissyi* the type of the genus and three years later Sharpe[64] enlarged the description of that species by giving an account of other anatomical features. The external form is similar to that of *Caprinuloidea perfecta.* Internally the general plan is the same but the details are somewhat different. Both valves have the caniculate or tube structure characteristic of the Caprinidæ. However, both valves have large polygonal accessory cavities between the smaller peripheral canals. These are confined for the most part to the dorsal and anterior areas. *B'* is relatively small and *B* does not appear. *V'p'*, *G* and *L*, are present but the other anatomical features of the hinge plate are rudimentary. In the lower valve the hinge and myophore structure of the hinge plate are rudimentary, being for the most part replaced by the large accessory canals.

The characteristic features of the genus are the numerous longitudinal accessory cavities which, together with the body cavity are septate (Pl. XIII, fig. 1). The peripheral canals made by the true vertical radial plates do not bear these septa.

Concerning the relationships of this genus d'Orbigny[65] said:

> "Although *Caprinula* has the external form of *Caprina* it is distinguished from it by the fact that the two valves are perforated by round canals while in *Caprina* only the upper valve is pierced by narrow canals. It is nearly related to *Caprinella (Ichthyosarcolites)* by the two caniculate valves but is distinguished from it by the lower valve not being coiled horizontally on the ground, by the upper valve not being conical, and by the lack of lateral perforated expansions." (Author's translation.)

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[64] Sharpe, Daniel, On the Secondary District of Portugal which lies on the north of the Tagus. Quart. Jour. Geol. Soc. Lond., vol. 6, p. 179, 1850.

[65] d'Orbigny, A., Paléontologie française, Terrains crétacés, vol. 4, p. 187, 1847.

This genus is well represented in different parts of Mexico as many fragments from widely separated localities bear witness. It is to be regretted, however, that no complete or even nearly complete specimens are thus far known. In view of this fact no attempt at a specific description has any merit or value.

Caprinula fragments are particularly abundant in the limestones near Santa Rosa in the state of Vera Cruz; the figured specimen (Pl. XIII, fig. 1) is from Paso del Rio, Colima.

Sabinia Parona 1908

In the original description of the genus *Sabinia,* Parona[66] says in part:

"Rudistids of the group of inverse forms. The form most frequent and best known of this genus of Caprinidæ resembles in external form the genus *Plagioptychus,* differing from it in the internal structure and essentially because both valves are caniculate. The cross-section of the two valves is characterized by the great number of small irregularly polyhedral (polygonal?) canals, almost uniformly disposed over the whole space of the internal layer of the shell, also on the part external to the cardinal apparatus, and by the absence of the true large canals or lacunæ outside of the muscular myophores, particularly of the anterior myophore.

"The fact of the presence of canals in the lower valve (right or fixed) distinguishes this genus from the genera *Plagioptychus, Caprina, Sphæru-caprina, Mitrocaprina* . . .

"The same fact of the canals in the lower valve recalls instead, the characters of the genera *Polyoptychus, Coralliochama, Caprinula* and *Schiosia.* The lacunose structure due to the great development of the canals in the two valves, particularly in the lower and the lack of all traces of the ligament, clearly distinguish the genus *Polyptychus* from our new genus. The numerous closely set small canals of this new genus suggest *Coralliochama* White . . . but we are far from that very fine and uniform cellular structure of this genus, . . .

"Thus the affinities with the genera *Caprinula* and *Schiosia* G. Boehm are closer: still it evidently differs from the first through the lack of the regular series of large canals in the posterior and anterior regions and particularly outside of the muscular myophores of the two valves; it differs from the second by the more uniform and more minute canal structure which do not appear due to marginal canals *included between the polyfurcating* plates as was clearly the case in *Schiosia,* so it recalls the regular polyfurcating disposition of the canals in *Plagioptychus* and *Caprina* while in the new genus *Sabinia* the disposition and the section of the smaller polyhedral (polygonal?) canals suggest those of the genus *Caprinula.*" (Author's translation.)

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[66] Parona, C. F. Notizie sulla fauna a rudiste dell pietra di Subiaco nella valle dell'Aniene. Bul. Soc. Geol. Ital., vol. 27, p. 303, 1908.

To Parona's original description may be added a few minor points. The engaged valves may closely resemble some forms of the genus *Plagioptychus* in having the lower valve short and conical and the upper valve horn-shaped (e.g. *Sabinia sublacensis* Parona) or both valves may be coiled to such a degree that the tips overlap (Pl. XIII, fig. 2, *S. orbiculata)* or the lower valve may be straight and elongated *(S. vivari,* Pl. XIV, figs. 1-4). The ligamental groove is deep. The canals, except those at or near the surface, are septate. The septa of the vertical canals, it seems, would cut off all communication between the living parts of the animal and the parts below the septa, except at the surface of the shell.

21. **Sabinia orbiculata** Palmer, new species

Plate XIII, figures 2, 3

The engaged valves form a circular coil with the free ends of the valves overlapping, forming a low flat spire of somewhat more than one turn. The shell is very thick dorsally and rather thin ventrally. It is largely made up of vertical polygonal tubes or canals in which the form of the primitive radial plates is nearly lost towards the inside but is clearly retained in and near the periphery (Pl. XIII, fig. 3). The outer edges or ends of the vertical plates branch once and the branches do not anchylose. Where the shell is somewhat worn these edges project giving the surface a fibrous appearance.

The muscle attachments *mp* and *ma* do not appear in the cross-sections. *B′* is well developed but not exceedingly large. *B* does not appear in the sections and has probably disappeared as is the case with *Planocaprina trapezoides.* *V′p′* does not extend to the plane of union of the shells, that is, the middle portion does not appear in the sections taken near the openings of the valves. *n* is partitioned and nearly as large as *m′*. The relative size of the valves is not known as the valves are so closely joined in the type specimen that their juncture is not determinable.

Holotype: No. 2177, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

This form has several points of similarity with *Coralliochama* of the Pacific Cretaceous. In both, the dorsal part of the shell is much thicker than the ventral; the greater part of the shell is composed of polygonal septate tubes irregularly disposed, those of *Sabinia,* however, are three or four times as large as those of *Coralliochama.* The exterior of both valves of *Sabinia orbiculata* is made up of unanchylosed branches of the vertical radial plates similar to *Caprinuloidea.* This detail of structure is also present in *Sabinia sublacensis* Parona from central Italy.[67] In *Coralliochama,* on the other hand, only the upper valve has this structure while the peripheral branches of the vertical radial plates of the lower valve unite to form the septate tubes. The disappearance of *B* is a notable feature of this species.

As with other species found at the same locality, the nearest kin to this form are southern European. Parona ascribes to the Senonian the beds in which the genus *Sabinia* is found in Italy.

22. **Sabinia totiseptata** Palmer, new species

Plate XIV, figure 5

The lower valve is straight or slightly curved; the upper valve is curved in a low spire. The shell wall of both valves is made up of round and polygonal septate tubes. The septa in the canals of the lower valve are concave and those in the upper valve are flat. The branches of the vertical radial plates anchylose forming polygonal septate tubes similar to those of the inner part of the shell wall in *S. orbiculata. S. totiseptata* may be distinguished from that form by the lack of the peripheral row of unanchylosed branches of the vertical radial plates (Pl. XIII, fig. 3).

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[67] Parona, C. F., Notizie sulla fauna a rudiste della pietra di Subiaco nella valle dell'Aniene. Bul. Soc. Geol. Ital., vol. 27, p. 301, 1908.

Holotype: No. 2178, Mus. Calif. Acad. Sci., from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

No muscle scars nor structures that can be definitely ascribed to teeth are present in the specimens at hand. It is possible, however, that sections definitely known to be near the openings of the valves might show these structures, the inference being that they are absorbed during the growth of the animal.

23. **Sabinia vivari** Palmer, new species

Plate XIII, figure 4; plate XIV, figures 1-4

The lower valve is elongated, curved, spiral or angulated. It may be triangular or quadrilateral in cross-section. The shell wall is very thick dorsally and thinner towards the ventral side. It is composed of three layers: (1) the inner, very thin; (2) the middle, thick and spongy, probably composed entirely of large, irregular, septate tubes and accessory cavities, the structure of which has been largely destroyed by the crystallization of calcite; and (3) the outer layer, made up of polygonal aseptate tubes .08 inch in diameter. The last give the striated structure to the surface of the shell. The body cavity is not septate and, like the other species of *Sabinia,* is very small. Ligamental groove very small and inconspicuous.

Upper valve unknown.

Syntypes: Nos. 2179, 2180, Mus. Calif. Acad. Sci., *paratypes,* Palmer collection; from **Paso del Rio, Colima;** collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

No trace of the hinge apparatus nor of the myophores is preserved in any of the specimens at hand.

The species is named in honor of my friend and former coworker, Sr. Gonzales Vivar, geologist of the Instituto Geologico, to whom credit is due for bringing this locality to public notice.

Radiolitidæ Gray

The general shape of the exterior of the shells of this family is so diverse that no single descriptive term can be applied.

The lower valve may be long, smooth and cylindrical with a few fairly well defined vertical furrows as in *Eoradiolites (Præradiolites* or *Radiolites) davidsoni* Hill; or conical and smooth with an undulating surface (Pl. XV, fig. 1); or with a corrugated, foliaceous surface (Pl. XVI, figs. 4-7; or they may be very flat with horizontally radiating plates that are recurved, horizontal or even decurved as in *Sphærulites.*

All forms of this family show at least two wide grooves, *E* and *S* (Pl. XVI, figs. 1, 2). These are understood to mark the location of the two siphons. They may be v-shaped in cross-section, narrow and flat, wide and smooth or ornamented with fine longitudinal lines. *E* indicates the siphon for the entering water and *S* the siphon for the out-going water. Between the two grooves there is an elevated interband *I.* In addition to these features some of the species show other ribs and grooves. Anterior to *E* is the ridge *V.* This is called the pedal fold on the supposition that it is a remnant of the area from which the foot emerged. Very often a ridge *P* (sometimes called *PD)* occurs posterior to *S.* What it reflects in the soft parts of the animal is not known. Writers do not agree as to whether the ridges or the grooves mark the actual siphonal or pedal openings.[68] In the forms at hand, where the upper valve is nearly complete the very small concavities in the edge of the upper valve are opposite to the ridges on the surface of the lower valve and not the grooves, indicating that the former mark the location of the siphonal areas.

The ligamentary spur or ridge is an important anatomical feature in the Radiolitidæ. Few or none of the forms show any external trace of a ligament. Internally, in all the older forms, the rudimentary ligament is marked by a vertical ridge (Pl. XVI, fig. 7). This feature is an ancient one and the stock *Agria-Eoradiolites-Præradiolites-Radiolites-Sphærulites* retained it in several species until the Santonian and in one species, *R. nouleti,* until Campanien. The Mexican species herein described belong to this stock.

The upper valve is operculate and may be convex, flat or concave.

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[68] For a discussion see "Sur la classification des Radiolitidés". Douvillé, H., Bul. Soc. Geol. Fr., 4th Ser., vol. 8, p. 308, 1908.

The family receives its name from the structure of the shell material of the outer and principal layer of the lower valve. This is composed of two series of very thin plates. One series is composed of inverted cones (text fig. 1, *f*) and resembles a stack of funnels piled one within the other. For convenience these will be referred to as "funnel plates". The other is made up of vertical, radial plates that radiate outward and cross the first (text fig. 1, *vr*). When these radiating plates do not branch, a horizontal section shows the surface to be reticulate with quadrilateral meshes. The result is that the shell mass is in reality composed of small, long, rhombic prisms that extend diagonally upward and outward through the outer shell layer. This is the case with the *Eoradiolites, Præradiolites, Agria, Radiolites* and a few others.

On the other hand, in *Biradiolites, Sauvegesia, Tampsia* and several others, the vertical radial plates branch more or less regularly and the branches coalesce. The result is as shown in text fig. 2, where the horizontal section shows a reticulated surface with polygonal or rounded meshes and the vertical section shows a series of rhombs.

This structure is unique and characteristic of the Radiolitidæ, rendering possible the identification of the family from a fragment.

It seems probable that the two types of structure of this family reasonably divide the family into two groups. However, this has not been followed and forms with branched vertical plates are placed in the same genus with forms whose radial plates are unbranched.

Pervinquiere stated that in *Durania bertonoli* Per. the polygonal form of the prisms seen in cross-section appears in the adults while in the young the prisms are rectangular. He figured several specimens of the same species showing both polygonal and rectangular prisms. However, the wide diversity in the forms illustrated suggests a diversity in the species. In *Biradiolites cornii-pastoris* d'Orb. the polygonal prisms are present equally in both the youngest as well as the oldest end of the shell.

The description of Fischer[68a] makes no mention of the reticulate structure and does not distinguish the Radiolitidæ from either the Monopleuridæ nor the Caprotinidæ unless the hinge apparatus and muscular myophores are exposed.

[68a] Fischer, P., Manuel de Conchyliologie et de Paleontologie conchyliologique, p. 1064, 1887.

The Radiolitidæ are very characteristically Cretaceous. Their ancestors are not definitely known though Douvillé stated[69] that they are descended from the *Monopleura*. The connection between the two, however, does not seem to be clear. The adductors of the *Monopleura* are set simply on the shell wall which may or may not be even thickened while in the Radiolitidæ these are set on elevated platforms in the lower valve and upon pendant areas in the upper valve. The former feature resembles the plan of the Horiopleuridæ. Also, the posterior muscle scar of the latter group, suspended from the upper valve, is like that of the Radiolitidæ. The upper free valve has two cardinal teeth and the lower fixed valve has one.

The structure of the shell of the Radiolitidæ somewhat resembles that of *Monopleura* by the composition of the outer layer, i. e. it is composed largely of funnel plates that surround the body cavity (text fig. 1). This, however, is common to nearly all lamellibranchiata. The traces of radial plates in *Monopleura* suggest Radiolitidæ but this structure, as has been pointed out under *Monopleura,* is a common minor detail structure of many other pelecypods. On the whole the two well defined series of plates distinguish the Radiolitidæ from the Monopleuridæ as well as from the other families.

Agria Matheron 1878

In his monograph on the Radiolitidæ Toucas[70] thus characterized the genus Agria:

"Lower valve generally quite elongated, more or less polygonal in cross-section, straight or slightly arched.

"External plates not very thick, smooth over the whole surface, often ornamented by longitudinal ribs separated and marked by striations or lines of growth; on the side opposite the cardinal region there are two longitudinal grooves which are quite large, deep and round and are separated by folds or ridges that are more or less projecting.

"Upper valve operculate and usually very concave, rarely flat and never convex, concentrically striated and having undulations corresponding to the folds of the lower valve.

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[69] Douvillé, H., Bul. Soc. Geol. Fr., 4th Ser., vol. 2, p. 460, 1902.

[70] Toucas, Memoire Soc. Geol. Fr., Paleontologie, No. 36, p. 17, 1907.

"Cardinal apparatus formed by two elongated teeth, nearly equal and by two muscular myophores that are somewhat projecting.

"Ligamental ridge or fold of the outer plates, very distinct in the older forms and disappearing in the younger forms at the beginning of the Coniacian. . . .

"*Agria* may be divided into two groups on the basis of the form of the grooves and the folds of the external plates:

"1. Group of *Agria blumenbachi.*
"2. Group of *Agria triangularis.*

"In the first group the folds are generally slightly projecting and the grooves but little excavated, the anterior (groove?) is larger than the posterior.

"In the second group, on the other hand, the folds form jutting ridges and the grooves are quite deep and the posterior one is always larger than the anterior." (Author's translation.)

24. **Agria gherzii** Palmer, new species

Plate XV, figures 1-5

Lower valve conical, rather smooth, with low, rounded flutings and ribs and showing a tendency toward the development of large, thick irregular, rounded vertical flanges (Pl. XV, fig. 2). A few irregular growth stages appear in the form of foliaceous horizontal ridges. Ligament buried in outer layer and not visible at surface. E and S shallow, inconspicuous channels.

Shell wall of two layers: the inner is thin and homogeneous; the outer is composed of simple vertical *(vr)* and of funnel *(f)* plates arranged as in text fig. 6. Both series are very thin and closely set; the *f* and *vr* plates are 120 and 150 ± to the inch respectively. This results in the structure of the shell being, in effect, minute prisms with rhombic cross-section. Body cavity partitioned by concave septa.

Upper valve operculate and convex; composed of two layers: the upper is apparently homogeneous around the center but towards the edge is composed of what appear to be curved and radiating tubes (Pl. XV, fig. 2, *a*). The lower layer is homogeneous though it shows concentric growth stages.

In the hinge apparatus the posterior myophore, *mp,* of the upper valve is long and pendant, opposite to and entering a deep pit which lodges the corresponding myophore of the lower valve. There is an extremely large accessory cavity in the upper valve that has the appearance of a large suspended sack which occupies a large portion of the body cavity. The dentition is not known.

Syntype: No. 2186, Mus. Calif. Acad. Sci.; *syntype,* Palmer collection; from **Paso del Rio, Colima**; collected by R. H. Palmer; July, 1924; Cenomanian, Cretaceous.

It is possible that the suspension of the posterior myophore *mp* directly from the under side of the upper valve and not from an appendage from the dental apparatus proper as in *Radiolites* may possibly remove this form to a new genus. However, as the complete inner structure of the shell is not yet known and the outer surface corresponds to the description of *Agria,* it is deemed wiser to ascribe it to this genus.

The appendage suspended from the upper valve which housed the large accessory cavity so nearly filled the body cavity of the lower valve that but little space remained for the vital parts of the animal.

The species is named in honor of Sr. S. E. Gherzi, the administrador of the hacienda at Paso del Rio.

Radiolites Lamarck 1801

Radiolites[71] has the same general form as *Agria,* though as a rule it is somewhat shorter. The funnel plates (Pl. XVI, fig. 1) are thick, imbricated and form angular ridges and grooves over the surface, giving a frilled, tucked and foliaceous appearance. *E* and *S* broad and smooth and rather square in outline, with strong, clear-cut growth stages; *V* and *P* usually well marked, appearing as vertical rows of projecting horns (Pl. XVI, fig. 2).

It is quite possible that *E* and *S* are but reflections of rudimentary organs that have persisted but have ceased to function. This is indicated by the fact that but rarely, even in joined valves, does a trace of any opening between the valves appear in this area. The perforation in the upper valve of

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[71] See Toucas, Memoire Soc. Geol. Fr., Paleontologie, No. 36, 1907, for a good description of the genus.

R. perforata probably assumed the function of the siphonal areas. Ligamental ridge always present as a low, thin, vertical ridge down the dorsal side of the body cavity. It is formed by a fold in the inner layer of the shell, hence never appears on the surface. The chalice[72] may be deep or shallow or with high or low angled walls.

The upper valve is either flat, concave or convex and often has a very large accessory cavity as in *Agria gherzii.*

The shell is composed of two layers: a thin porcellaneous inner layer and a thick outer layer which is made up of vertical and funnel plates. All the surface features of the genus are located in this layer.

In the three species described, the outer layer is composed of the funnel and the unbranched vertical plates, i.e. the structure corresponds to the primitive form shown in Pl. XV, fig. 1.

Toucas stated that *Radiolites* was derived from *Præradiolites* and made its appearance at the base of the Turonian with *Radiolites peroni.*

Representatives of this genus are found in the Turonian in various parts of Mexico. Species similar to those described from Huescalapa are very common in the limestone east of Cuernavaca in the state of Morelos and near Atotonilco el Grande in the state of Hidalgo on the east side of the highland. This genus affords the best means thus far known for correlating many widely separated exposures of the Turonian.

25. **Radiolites robusta** Palmer, new species

Plate XVI, figures 1-3

Short and robust, diameter about equaling the height; body cavity rounded or oval, outer surface corrugated; shell wall very thick. *P, S, I, E* and *V* well developed. The growth stages jut out giving the shell a foliaceous appearance; some of these are horizontal or nearly so. The growth stages cross the siphonal grooves by a decided turn upward and the ridges (*P*, *I* and *V*) by an equally sharp turn downward (Pl. XVI, fig. 1). The margins are smooth and lie flat in *E* and *S* but project outward as horns on the ridges; *I* is square and massive, *P* and *V* are angular and *E* and *S* are rounded or V-shaped in cross-section.

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[72] The term chalice is applied to that part of the lower valve above the ridge or flange on which rests the periphery of the upper valve (Pl. XVI, fig. 7). It is the portion of the outer shell layer that extends above the inner layer. As applied to the upper valve it is the cup-shaped depression formed by the elevated border and the valve proper (Pl XVI, fig. 3).

The chalice is low and somewhat spreading as in *R. inflata*. The upper valve is flat (Pl. XVI, fig. 3) but is supplied with a low elevated border as in *R. perforata*.

The dentition and the myophores of neither valve are known.

Syntypes: Nos. 2181, 2182, Mus. Calif. Acad. Sci., *paratype*, Palmer collection; from **Huescalapa, Jalisco**; collected by R. H. Palmer; Aug., 1922; Turonian, Cretaceous.

The rugged, robust appearance and thick shell distinguish this form from other species. It resembles *R. inflata* by being very low and having the low, narrow, spreading chalice but the flat upper valve, the elevated margin and lack of an accessory cavity in that valve and the thick shell wall of the lower valve distinguish it from that species.

The arrangement of the vertical radial and the funnel plates is the same as in *Agria ghcrzii* (Pl. XV, fig. 5).

26. **Radiolites perforata** Palmer, new species

Plate XVI, figures 4-11; plate XVII, figure 1

Shell small, 2 inches long and 1½ inches wide at the aperture; cone-shaped, circular in cross-section, has general appearance of a stack of corrugated cones each cone representing a growth stage. The upper, mature, growth stages are often flaring and wide-spread (Pl. XVI, fig. 4). Corrugations sharp-angled. Ligament present as a narrow, low ridge extending down the body cavity (Pl. XVI, fig. 7). The ligament is a fold in the thin inner layer and does not appear in the outer layer (Pl. XVI, fig. 7). The siphonal grooves and the bounding ridges well developed; *P*, *S*, *E* and *I* are square and angled in cross-section and *V* is triangular. The growth stages on *S* and *E* scarcely show while on the intervening ridges they extend upward and outward as horns (Pl. XVI, fig. 4).

The upper edge of the inner shell layer forms a flange on which rests the upper valve (Pl. XVI, figs. 7, 8). The outer layer forms the wide, high and more or less spreading chalice.

The upper valve is thin and slightly concave. Around the periphery is a high thin curtain-like border or mantle that extends to the upper edge of the chalice of the lower valve (Pl. XVI, fig. 9). This mantle enters the corrugations and the undulations of the chalice and so completely covers it that it is questionable if it did not effectually seal the juncture of the two valves. The extreme thinness and resulting fragility of this border and its preservation in the fossil state indicate that the upper valve had little or no movement but for the most part rested upon the folds in the chalice and the flange of the lower valve.

The upper valve is perforated (Pl. XVI, figs. 9, 10). This perforation may possibly have been used by the animal as a conduit through which it received oxygenated water and food from the outside. This is in accordance with the extremely well fitting union between the two valves.

The upper valve shows both radial and concentric structures, indicating that it is similar to that of the lower valve (Pl. XVI, fig. 10). It consists of a series of funnel plates that grew by the addition of larger plates on the under side of the smaller and older parts. The exposed edges of these give the concentric form. To the vertical radial plates is due the radial structure.

Unfortunately nothing is known of the internal structure of the species except the fact that the entire dental and myophore apparatus was suspended from the upper valve by a strong pillar (Pl. XVI, fig. 8) as in typical *Radiolites*. This is in contrast with the arrangement of the myophores in *Agria gherzii*.

Syntypes: Nos. 2183, 2184, Mus. Calif. Acad. Sci.; *paratype*, Palmer collection; from **Huescalapa, Jalisco**; collected by R. H. Palmer; Aug., 1922; Turonian, Cretaceous.

27. **Radiolites inflata** Palmer, new species

Plate XVII, figures 2-4

Lower valve low and wide; oval in cross-section; small and regular; vertical corrugations covering surface. Growth stages very regular and forming well defined horizontal, foliaceous ridges as in *R. perforata.* *P, S, I, E* and *V* as in *R. perforata;* chalice low and narrow and nearly horizontal.

Upper valve smooth, convex, apex somewhat ventral; below the surface is a large cavity (Pl. XVII, fig. 3) which is bounded below by the lower surface of the shell from which is suspended the hinge apparatus. Opposite *V* and near the margin of the valve is a small opening leading to the body cavity. The margin of the upper valve is without the elevated mantle of *R. perforata.*

Hinge apparatus unknown.

Holotype: No. 2185, Mus. Calif. Acad. Sci., from **Huescalapa, Jalisco**; collected by R. H. Palmer; Aug., 1922; Turonian, Cretaceous.

The species is distinguishable from the others by the smooth, inflated, convex upper valve. The lower valve resembles *R. robusta* in being low and having the low, narrow, spreading chalice, but is distinguished by the fine and regular vertical corrugations and the thinness of the shell wall.

Dorsally, the upper valve seems to be attached to the lower valve by shell material. This points to the conclusion mentioned in the discussion of *R. perforata* to the effect that the opening in the upper valve may have assumed the function of the siphonal grooves and that the upper valve was practically immobile.

28. ? **Sphærulites** sp.

Plate XVII, figure 5

This curious form occurs with the *Radiolites.* It is very low and flat and the shell wall is thick. The growth stages are very foliaceous, rugose, long and spreading and over half the surface, curve downward, as a result of which the vertical corrugations so commonly seen in the Radiolitidæ are largely concealed. There is no definite trace of an internal ligament nor of *E* and *S*. The flat, foliaceous form with the plates spreading and decurved suggests *sphærulites* but the lack of clear cut characteristics of the lower valve and the absence of the upper valve preclude ascribing it definitely to any known genus. The presence of the radial and of the funnel plates, however, show it to belong to the Radiolitidæ. Upper valve unknown. The lower flat side probably represents a surface against which or on which the individual grew. The presence of beekite bodies is worthy of note.

The specimen figured is from the Turonian of Huescalapa, Jalisco.

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February 29, 1928

Plate 1.

Immanitas anahuacensis Palmer, new species, p. 30.

View of upper side, both valves.

Note low spire, i. e., the umbo of valve on the left side turns down and that on the right turns up and the rope like fold that extends from tip to tip, this fold is 25″ long.

The specimen is 16″ long and $5\frac{1}{2}$″ wide. Paso del Rio, Colima, Mexico. Cenomanian, holotype. The right valve is uppermost on the plate.

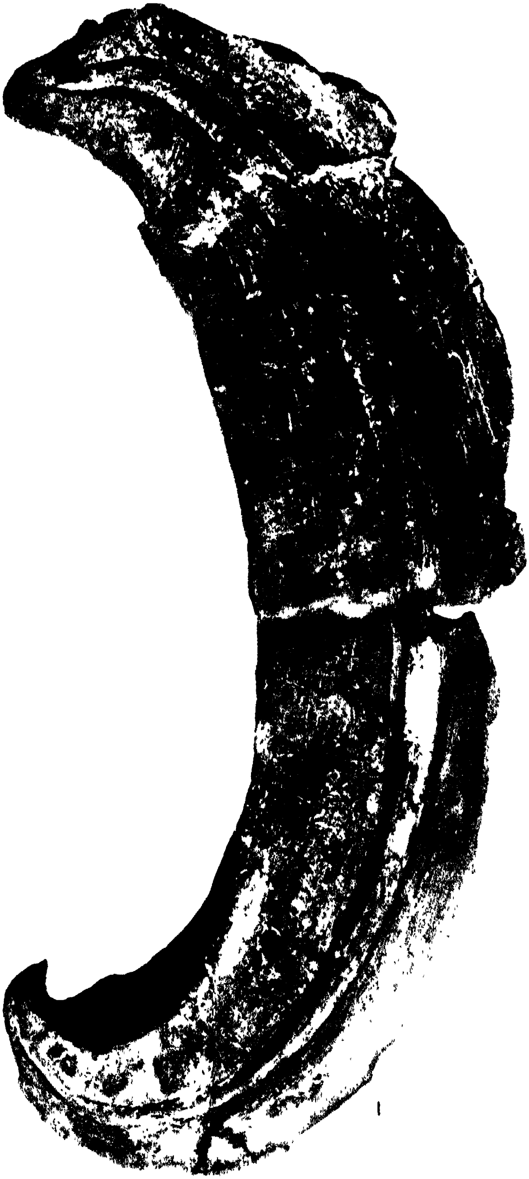

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Plate 2.

Fig. 1. *Immanitas anahuacensis* Palmer, new species, p. 30.

View of ventral side of specimen shown on Pl. 1.
W. Rope-like fold.
a, b Grooves bordering *W.*
Note low spire and flat or concave dorsal side.

Holotype: Paso del Rio, Colima, Mexico, Cenomanian.

Figs. 2 and 3. Sections of the right (3) and left (2) valves of the type.

a. Thin, wide, flaring, concave keel on ventral convex side.
G. Body cavity.
W. Rope-like fold.
c. Attached area of *W.*
X, Y & Z. Cavities, function not definitely known.

Holotype; Paso del Rio, Colima, Mexico, Cenomanian.

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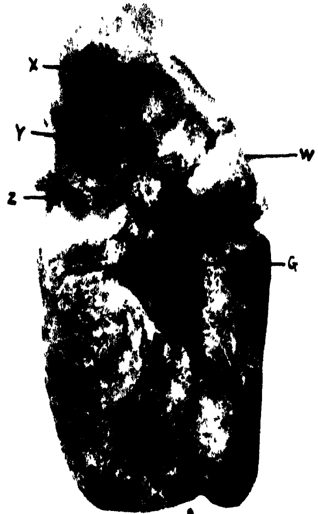

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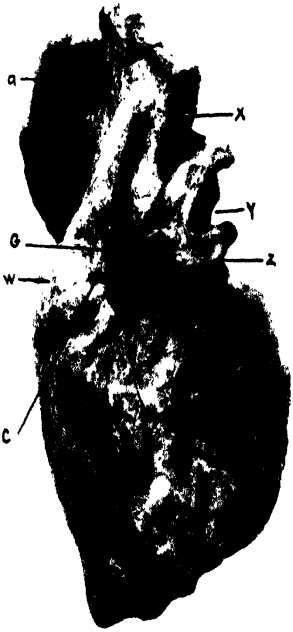


PLATE 3.

Immanitas anahuacensis Palmer, new species, p. 30

Coiled specimen of one valve. The total length of the coil is 25 inches. W. Rope-like fold.

Paratype, No. 2154 (C.A.S.), Paso del Rio, Colima, Mexico, Cenomanian

1

Plate 4.

Fig. 1. *Immanitas anahuacensis* Palmer, new species, p. 30.

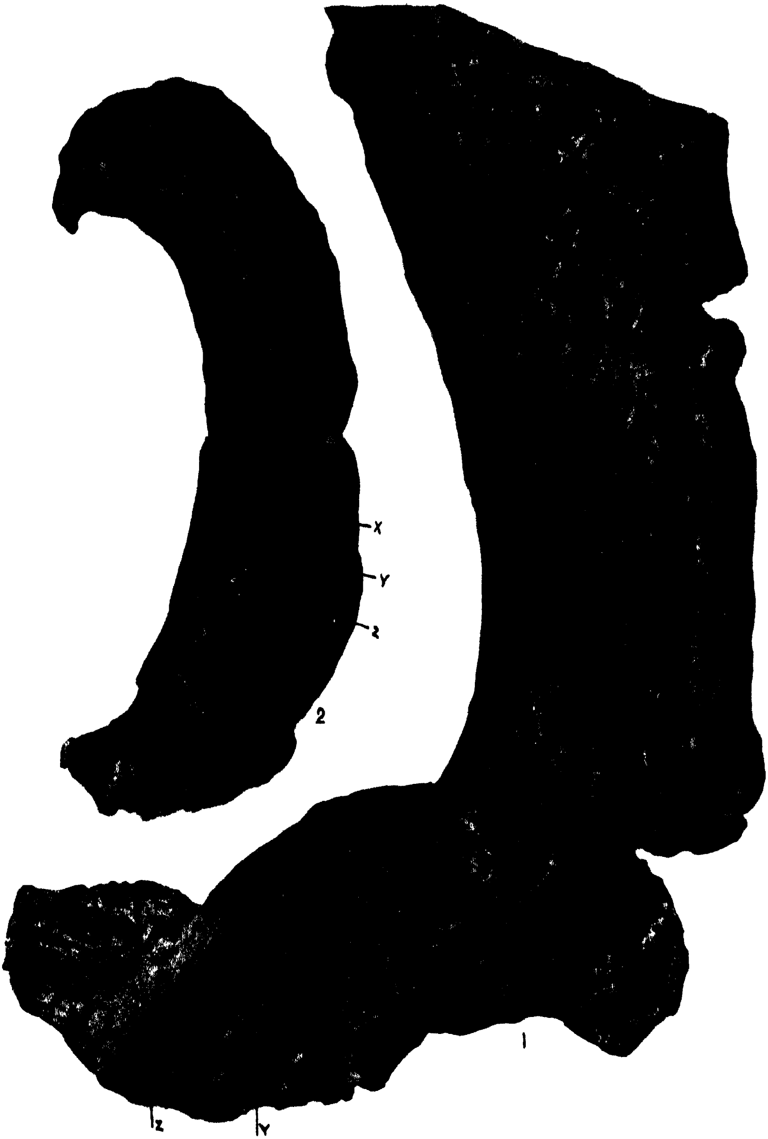
Horn-shaped specimen. Note long open coil. The specimen is 25" long. Paratype, (L. S. J. U. Coll.), Paso del Rio, Colima, Mexico, Cenomanian.

Fig. 2. The same, p. 30.

Under side of type specimen.

X, Y & Z. Cavities. These are exposed only in the valve on the left side.

Paso del Rio, Colima, Mexico, Cenomanian.


x
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2
1
z
y

Plate 5

Fig. 1. *Immanitas rotunda* Palmer, new species, p. 32.

Sections of valve, slightly enlarged, $3\frac{1}{4}''$ diameter

a	Edges of concave septa of body cavity
G	Body cavity.
X	Longitudinal cavities joined towards center of shell
H	Rope-like fold deeply imbedded in shell material

Note cellular structure of shell proper and of X and H. In *X* there are aggregations of cells that suggest fleshy tissue.

Holotype, No. 2155 (C. A. S.), Paso del Rio, Colima, Mexico, Cenomanian.

Figs. 2-5. *Palus corrugatus* Palmer, new species, p. 33.

Sections of lower valve taken progressively from aperture towards base. Enlarged $1\frac{1}{2}$.

G	Body cavity
B'	Fragment of anterior tooth of upper valve
B	Fragment of posterior tooth of upper valve
X	Tooth of lower valve
L.	Ligament
f	Folds in outer shell layer which appear as corrugation on surface (fig. 4)
V'a'	Ventral-anterior keel of *B'*
V'p'	Ventral-posterior keel of *B'*

Note the thinner outer layer and the inner layer that becomes thicker towards the base. Nearer the base the inner layer completely fills the body cavity.

B and *B'* are remnants of the teeth that were broken and remained in the sockets.

Dorsal views of same specimens on Pl. 17, figs. 6-8.

Syntypes, 2156, 2157 (C. A. S.), Paso del Rio, Colima, Mexico, Cenomanian.

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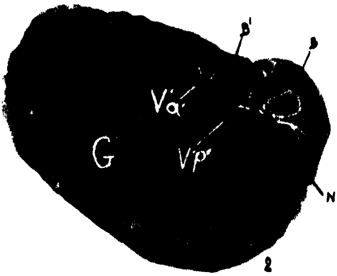

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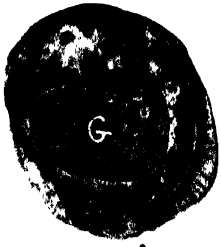

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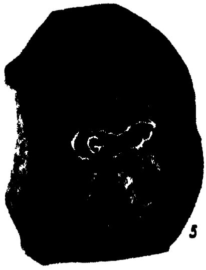

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Plate 6

Figs. 1-3 *Bayleoidea clivi* Palmer, new species, p. 38.

Length $2\frac{1}{2}''$

- *a* Lower valve; this is long and tubular and slightly spiral
- *b* Upper valve, small and semi-operculate, letter omitted on fig. 2, it should be at the extreme top
- *mp* Posterior myophore of lower valve
- *m'p'* Posterior myophore of upper valve
- *o* Accessory cavity
- *m* Thin keel bordering the area on which the animal rested

This form is almost an exact duplicate of *Toucasia* sp. (Pl. 18, fig. 2) *except* that the new species rested on the *posterior* side while *Toucasia* rested on the *anterior*. In either case the longer valve was of necessity the lower valve. (p. 37)

Note the transverse wrinkles and small longitudinal lines on upper surface. (Fig. 3)

Holotype, No. 2158 (C. A. S.), Huescalapa, Jalisco, Mexico, Turonian.

Fig. 4 *Requienia* sp., p. 39.

Size of specimen $1\frac{3}{4}''$. Compare with fig. 5 and Pl. 18, fig. 3.

- *m* Myophore ridges

Note remnant of spire and longitudinal sculpturing.

Huescalapa, Jalisco, Mexico, Turonian.

Fig. 5 *Requienia patagiata* White, p. 39.

Edwards limestone of Texas.

Figs. 6-7 *Apricardia chavesi* Palmer, new species, p. 42.

Upper surface, height $2\frac{3}{4}''$ (fig. 6)

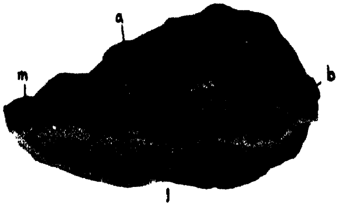
- *a* Larger attached valve. The tip of the umbo was the area of attachment. The animal was in a horizontal position with both beaks turning downward.
- *b* Smaller free valve. Fine longitudinal striation visible on this valve in fig. 7.
- *c* Ridge along which the two valves joined on under side.

Holotype, No. 2159 (C. A. S.); five miles north of Soyatlan de Adentro, Jalisco, Mex., Turonian.

Figs. 8-9 *Apricardia asymmetrica* Palmer, new species, p. 43.

- *a* Flat, disc-shaped attached valve.
- *b* Free valve. Note resemblance to segment of an orange; also large vacant area enclosed by the upper valve. (fig. 8)
- *c* Area of attachment.
- *d* The ends of the upper valve meet at *d*.

Holotype, No. 2160 (C.A.S.), Paso del Rio, Colima, Mexico, Cenomanian.



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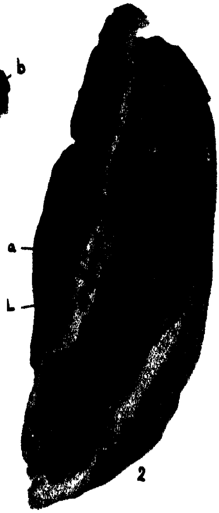

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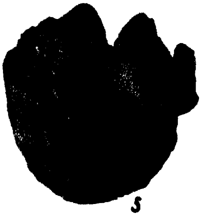

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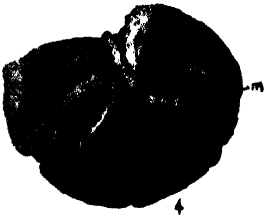

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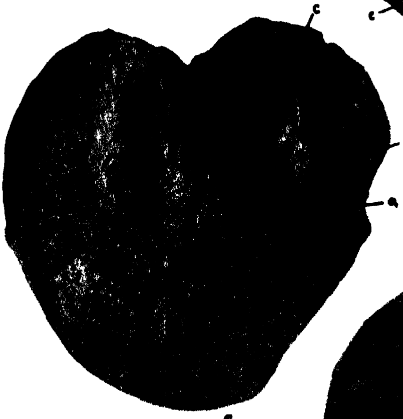

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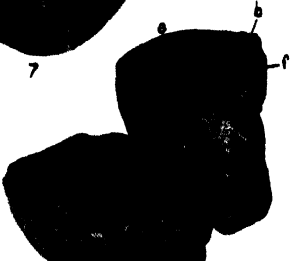

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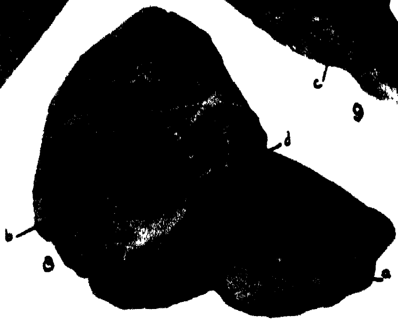

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Plate 7.

Figs. 1-3. *Monopleura salazari* Palmer, new species; p. 45.

Fig. 1. Dorsal anterior side 4"x3¼"
- *a.* Area of attachment of lower valve
- *b* Convex lenticular operculate upper valve
- *L* Ligamental groove

Note large horizontal growth stages

Syntype, No. 2161 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig. 2 Dorsal-anterior view, 4½"x2", p. 45
- x Large fragment of another individual of colony

Growth stages well defined

Syntype, Stanford collection

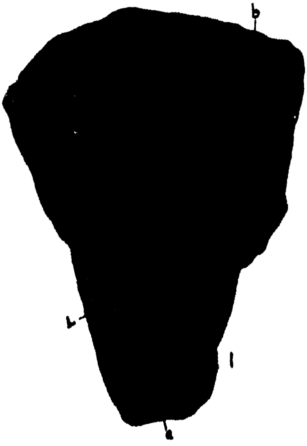
Fig. 3. View of interior of lower valve shown in fig. 2
- *b* Posterior dental socket
- *b'* Anterior dental socket
- *N* Thin erect tooth of lower valve
- *L* Ligament
- *i* Inner shell layer
- *o* Outer shell layer
- *ma* Location of anterior myophore
- *mp* Location of posterior myophore

Fig. 4. *Tepeyacia corrugata* Palmer, new species, p. 46.

View of anterior side of lower valve, length 3⅜".
- x Large fragment of another individual of same colony.

Holotype, No. 2162 (C.A.S.), Tepeyac Mountains, Puebla, Mexico, Turonian.

Fig. 5. Cross-section of specimen shown in fig. 4, taken below aperture.
- *i* Inner shell layer.
- *o* Outer shell layer, there are no vertical radial plates
- *E & S* Areas of inhalant and exhalant siphons. *E* is the deeper and is marked on the surface by a deep, wide furrow.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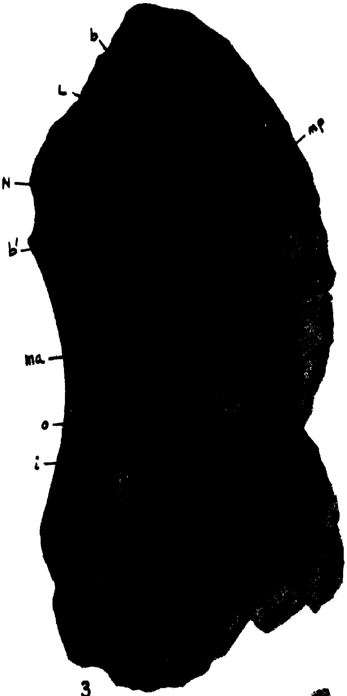
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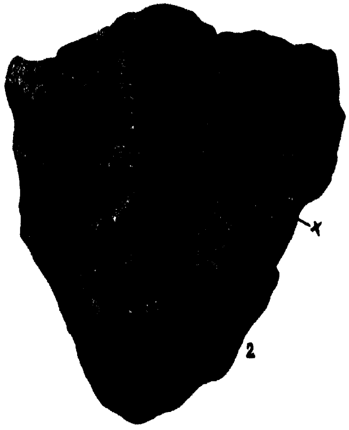
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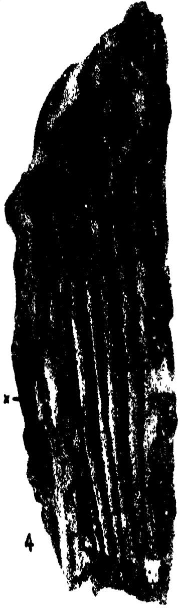
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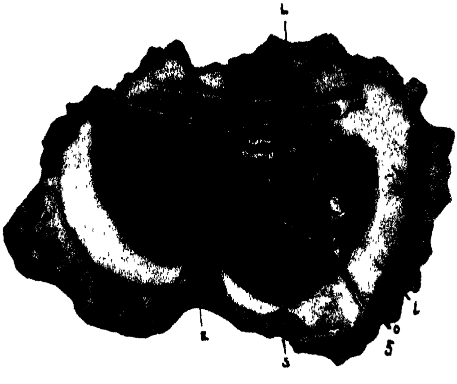

L
R
S
5
o
L

Plate 8.

Figs. 1-5. *Horiopleura gregaria* Palmer, new species; p. 49.

All figures natural size, figs 1, 4 and 5 Syntypes, Nos 2163-2165; Paso del Rio, Colima, Mex; Cenomanian. Note corrugated surface and operculate upper valve in fig. 1.

Fig. 2. Two individuals of a colony.
L. Ligamental groove exposed by removal of outer shell layer.

Fig 3 Section near aperture.
L Ligamental groove
E & S Areas marking the inhalent and exhalant siphons
Note two shell layers.

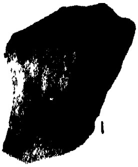
Fig 4 View of interior of lower valve.
ma Anterior myophore
mp. Posterior myophore
b' Anterior dental socket.
b Posterior dental socket
N Erect tooth of lower valve
G. Body cavity.

Fig 5 Longitudinal section of both valves
B. Posterior tooth of upper valve.
mp. Pendant posterior myophore
a Accessory cavity of upper valve.
o Outer shell layer
i. Inner shell layer

Fig. 6 *Chaperia socialis* Palmer, new species, p. 50.
Both valves, ventral side, natural size
s Siphonal area
Holotype, No 2166 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico; Cenomanian.

Fig. 7. *Baryconites multilineatus* Palmer, new species, p 52
Lower valve, height 5″.
ma Triangular anterior myophore
mp Linear posterior myophore
b' Anterior dental socket
b. Posterior dental socket.
N Tooth of lower valve.
L Ligament
i. Inner shell layer.
o Outer shell layer
G Body cavity.
E Area of inhalant siphon, this is marked by fine lines
Holotype, No. 2167 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico, Cenomanian

Fig. 8 *Caprinuloidea perfecta* Palmer, new species, p. 59.
Upper, free, left (α) valve; 1″.
B' Anterior tooth.
B Posterior tooth.
L. Ligament.
Syntype, No 2168 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico; Cenomanian.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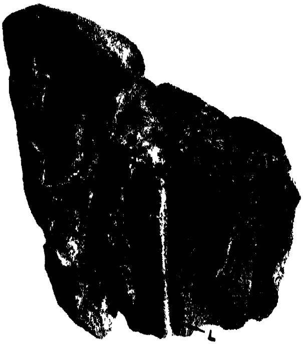

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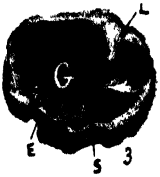

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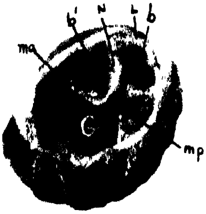

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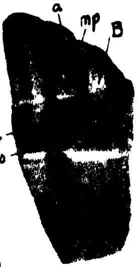

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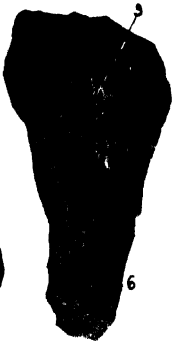

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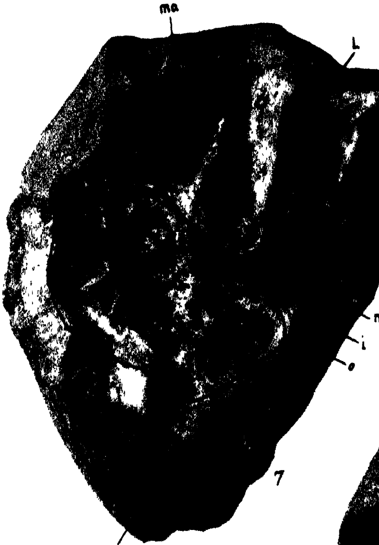

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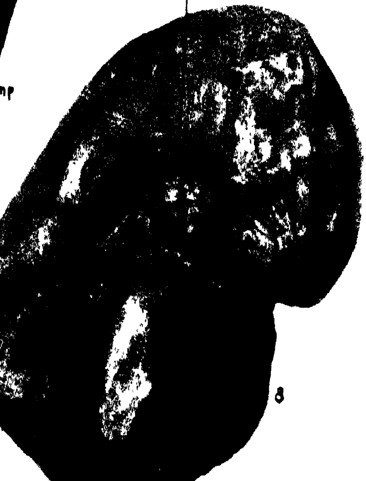

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Plate 9.

Fig. 1. *Caprinuloidea perfecta* Palmer, new species, p. 59.

Upper, free, left (α) valve, 4″.
a Flat anterior side
k Ventral anterior keel, this and *a* are more or less marked throughout the genus
B Posterior tooth
B′ Anterior tooth
V′p′ Ventral-posterior keel of *B′*, the partition between *G* and *m′*.
G Body cavity
m′ Cavity accessory to *n*

Note bifurcations of vertical radial plates in *k*

Syntype, No. 2168 (C. A. S.), Soyatlan de Adentro, Jalisco, Mexico, Cenomanian

Fig. 2. The same, both valves of holotype.

a b measures 13½″, total length from point of attachment (*a*) to beak of upper valve 23½″, diameter 2½″
L Ligamental groove
a Point of attachment
f Old fracture healed during life of animal

The figure shows the engaged valves essentially in the position assumed during the life of the animal

Soyatlan de Adentro, Jalisco, Mexico, Cenomanian

Fig. 3. *Caprinuloidea perfecta gracilis* Palmer, new sub-species, p. 60.

Length in straight line 6½″
a Point of attachment
L. Ligamental groove

Holotype, No. 2169 (C. A. S.), Soyatlan de Adentro, Jalisco, Mexico; Cenomanian

Fig. 4. *Caprinuloidea septata* Palmer, new species, p. 62.

Base of lower, attached, right (β) valve, 1¼″
b′ Anterior dental socket
b Posterior dental socket
m Cavity accessory to *b*.
G Body cavity
s Portions of concave septa

Holotype, No. 2171 (C. A. S.), Soyatlan de Adentro, Jalisco, Mexico; Cenomanian

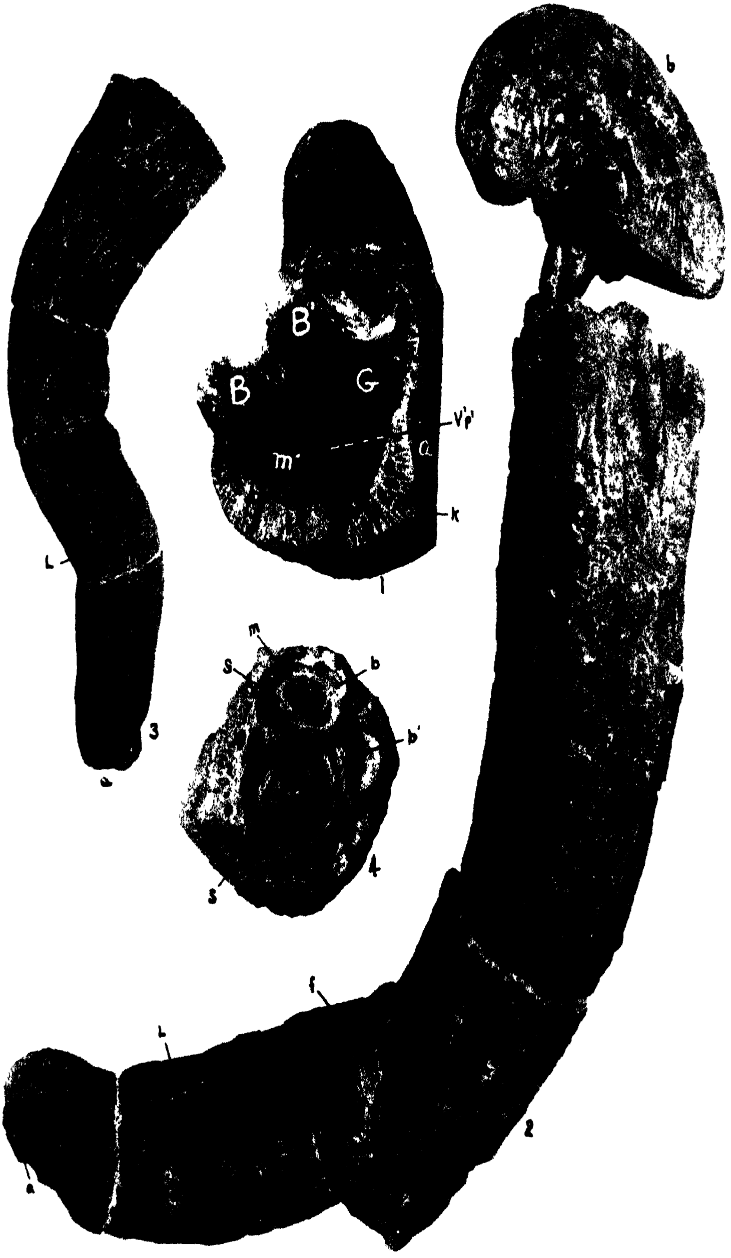

b
L
a
3
B'
B
G
V'p'
a
m'
k
1
m
S
b
b'
s
4
f
L
a
2

Plate 10

Fig. 1. *Caprinuloidea perfecta gracilis* Palmer, new sub-species, p. 60.

Lower, fixed, right (β) valve, section somewhat below aperture; enlarged 3½ times, same specimen Pl. 9.

b.	Posterior dental socket
b'.	Anterior dental socket
G	Body cavity
L	Ligamental groove
m	Cavity accessory to *b*, this cavity was probably formerly occupied by the posterior muscular myophore which has been reduced to *mp.*
mp.	Posterior myophore.
ma	Anterior myophore.
N.	Tooth
k	Ventral anterior keel
Da.	Dorsal anterior keel of *N*, the two teeth of the upper valve engage *Da* rather than *N*
Va	Ventral-anterior keel of *N*
Vp	Ventral-posterior keel of N
Dp	Dorsal-posterior keel of *N*.

Note the bifurcating vertical radial plates which, with the cavities they form, make up the thick inner shell layer. The fused outer edges of the vertical radial plates form the outer shell layer. Note also the trapezoidal outline of the specimen.

Holotype, No. 2169 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig. 2. *Caprinuloidea multitubifera* Palmer, new species, p. 61.

Upper, free, left (α) valve, enlarged 1½

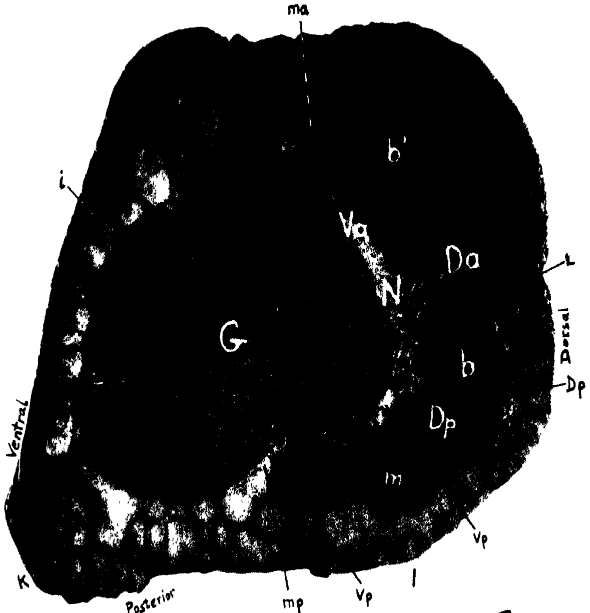
L_1.	Ligamental groove.
L	Ligament.
B'	Anterior tooth.
B	Posterior tooth
ma	Anterior myophore
mp	Posterior myophore
V'a'	Ventral-anterior keel of *B'*
V'p'.	Ventral posterior keel of *B'*
N	Fragment of tooth of lower valve, this completely fills the cavity *n*
m'	Cavity accessory to *n*

Holotype, No. 2170 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig. 3. *Caprinuloidea septata* Palmer, new species; p. 62.

Natural size, same specimen shown on Pl. 9, fig. 4. Note septate canals exposed by removal of outer shell layer

Holotype, No. 2171 (C.A.S.). Soyatlan de Adentro, Jalisco, Mexico, Cenomanian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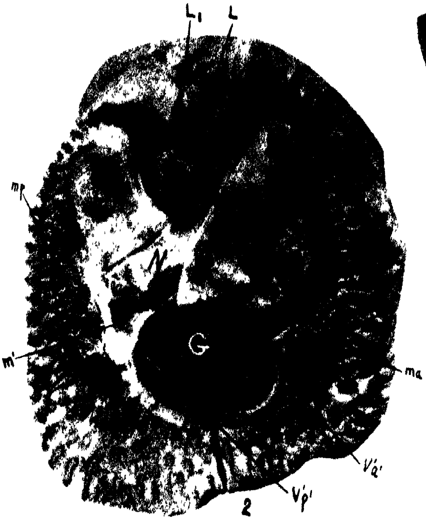
L₁
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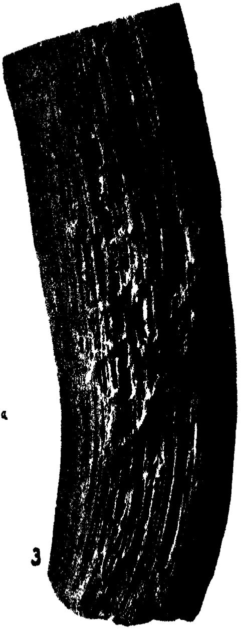

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Plate 11.

Fig 1. *Caprinuloidea septata* Palmer, new species; p. 62

Section of lower, attached, right (β) valve, enlarged 1½.

- *N.* Tooth.
- *b* Anterior end of posterior dental socket.
- *b'*. Anterior dental socket
- b_1 Posterior end of posterior dental socket
- *m.* Cavity accessory to *b*.

Note edges of concave septa in *b* and *m* The morphological characters are identical with *Caprinuloidea perfecta* var. *gracilis*.

Paratype, Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig 2 *Caprinuloidea costata* Palmer, new species, p 62

Lower, attached, right (β) valve, length 4"

- *L* Ligamental groove.

Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig 3 The same

Lower valve, length 3¾" Note horizontal ribs.
Syntype, No 2173 (C A S)

Fig 4 The same

Upper, free, left (α) valve, length 3¾ inches

- *L* Ligamental groove.

Note horizontal ribs.

Fig 5. The same

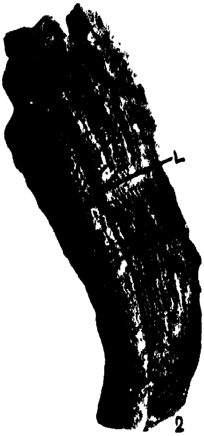
Upper, free, left (α) valve, enlarged twice

- *B'*. Anterior tooth.
- *B*. Posterior tooth
- *n* Dental socket of *N*
- *m* Cavity accessory to *n*
- *V'a'* Ventral-anterior keel of *B'*.
- *V'p'*. Ventral posterior keel of *B'*.
- *D'p'*. Dorsal-posterior keel of *B*
- *ma.* Anterior myophore
- *mp* Posterior myophore.
- *L* Ligament
- *e* Enlarged outer edge of vertical radial plates The union of these enlargements forms the outer shell layer (see p 54 & Text fig 6)
- *u.* Point of fused union between adjacent plates (p 55)

Note thin inner layer and thick middle layer composed exclusively of vertical radial plates.

Most of the canals formed by the ramifications of the vertical radial plates are filled with calcite The dark ones are filled with silt

Syntype, No 2172 (C A S) Soyatlan de Adentro, Jalisco, Mexico; Cenomanian



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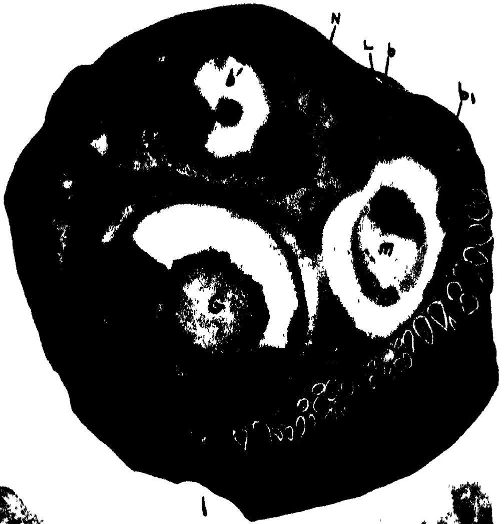

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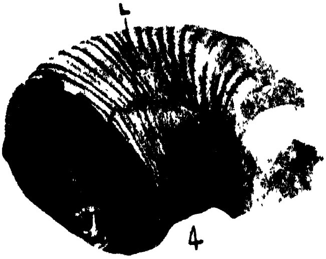

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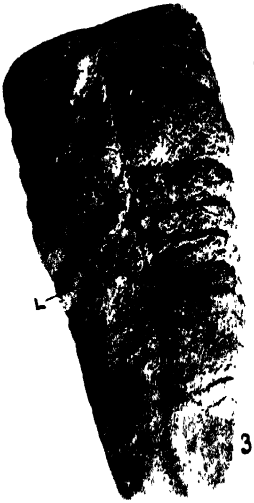

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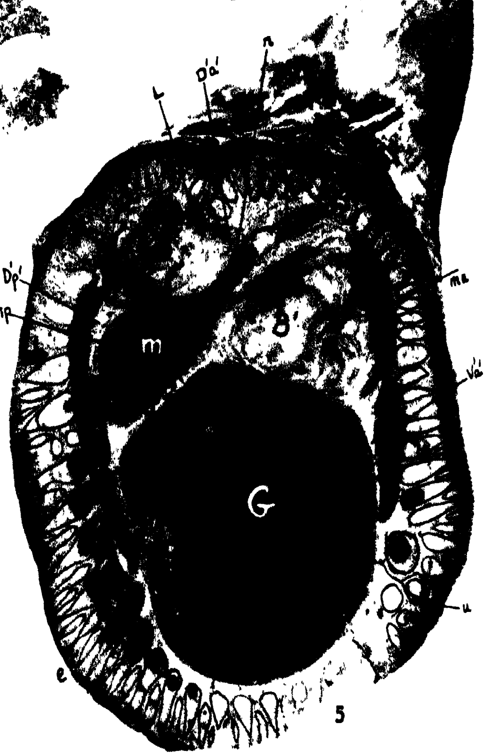

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Plate 12.

Fig. 1. *Caprinuloidea bisulcata* Palmer, new species, p. 64.

Lower, fixed, right (β) valve, natural size.
L. Ligamental groove.
a. Accessory groove.

Holotype. No. 2171 (C.A.S.), Soyatlan de Adentro, Jalisco, Mexico. Cenomanian.

Fig. 2. The same.

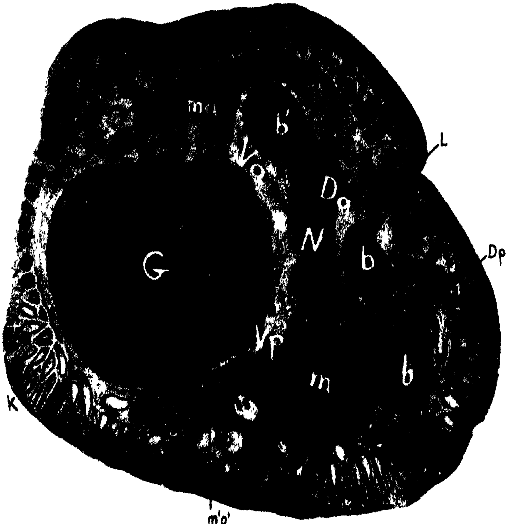
Section of specimen shown in Fig. 1, enlarged 1½. For explanation see Pl. 10, fig. 1.
k. Ventral anterior keel, note line of union between adjacent *vertical radial plates* (marked by white lines). See p. 55.

Fig. 3. *Coalcomana ramosa* Boehm, p. 69.

Slightly reduced.
L. Ligamental groove.

Soyatlan de Adentro, Jalisco, Mexico, Cenomanian.

Fig. 4. Section of specimen shown in Fig. 3. For explanation see Pl. 10, fig. 1.



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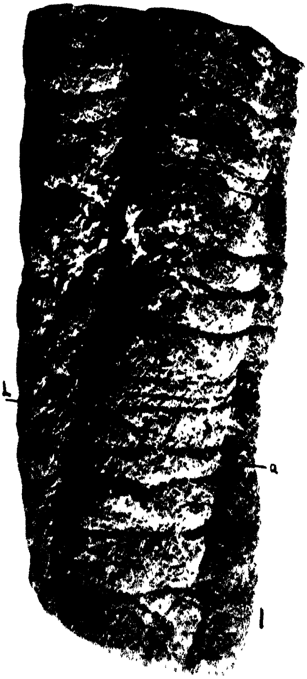

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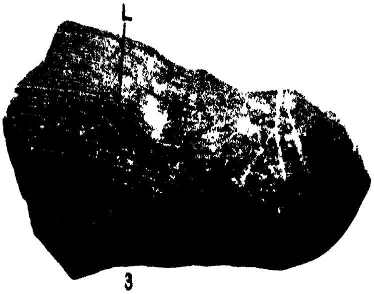

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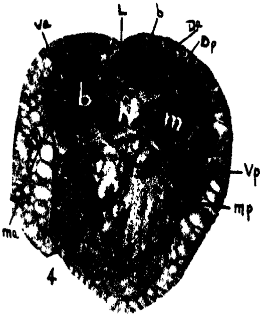

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Plate 13

Fig. 1. *Caprinula* sp.; p. 71.

Natural size.

G. Body cavity with concave septations.

o. Accessory cavities.

Plesiotype, No. 2187 (C. A. S.); Paso del Rio, Colima, Mexico, Cenomanian

Fig. 2. *Sabinia orbiculata* Palmer, new species, p. 72.

Measurement along cut 3½".

a. Beak of upper valve overlapping beak of lower valve.

Holotype, No. 2177 (C. A. S.), Paso del Rio, Colima, Mexico, Cenomanian

Fig. 3. Section of upper valve of type.

For explanation see Pl. 10, fig. 1.

B. Normal position of posterior tooth which is lacking.

o. Accessory cavities.

Note that *n* is partitioned.

The structure of the plates and canal both at the periphery and in the interior is the same as in *Coralliochama*.

Fig. 4. *Sabinia vivari* Palmer, new species; p. 74.

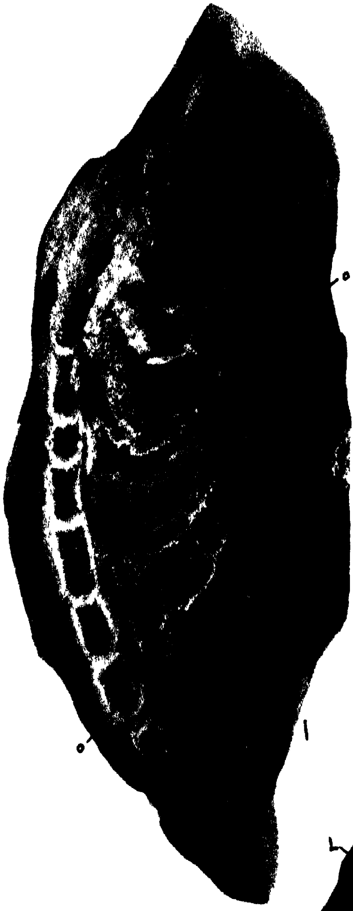
Cross-section; slightly reduced.

G. Body cavity.

L. Ligamental groove.

The specimen shows no trace of myophores nor of dental apparatus.

Paso del Rio, Colima, Mexico, Cenomanian



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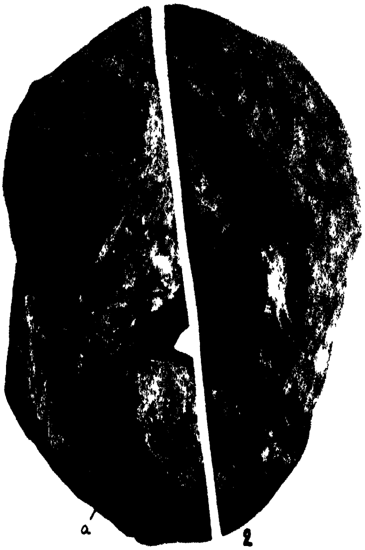

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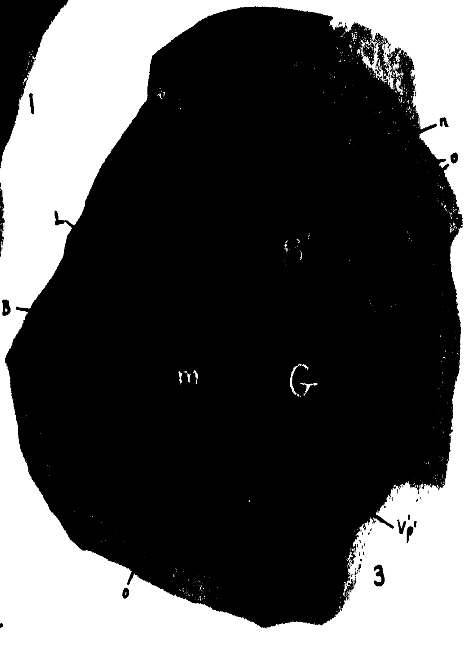

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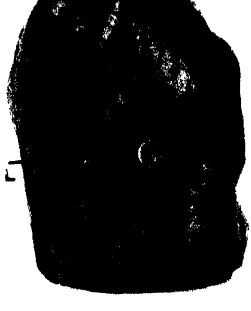

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Plate 14.

Fig. 1. *Sabinia vivari* Palmer, new species; p. 74.

Length 6½″. Note striated surface.

Syntype, No. 2179 (C.A.S.); Paso del Rio, Colima, Mexico, Cenomanian.

Fig. 2. Another specimen showing coil, length 4″.

Syntype, No. 2180 (C.A.S.); Paso del Rio, Colima, Mexico, Cenomanian.

Fig. 3. Section of specimen shown in fig. 1.

Ls. Ligamental spur.

L. Ligamental groove.

The vertical radial plates and canals appear in the periphery. Toward the interior the structure has been lost by crystallization.

Syntype, No. 2179 (C.A.S.).

Fig. 4. Another specimen slightly coiled, height 3¾″.

Paso del Rio, Colima, Mexico; Cenomanian.

Fig. 5. *Sabinia totiseptata* Palmer, new species, p. 73.

Longitudinal section showing edge of vertical radial plates between which are the septate canals. All the septations are concave. Enlarged twice.

Holotype, No. 2178 (C.A.S.); Paso del Rio, Colima, Mexico, Cenomanian.

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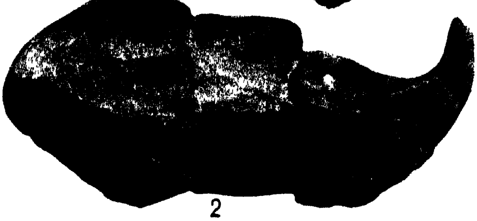

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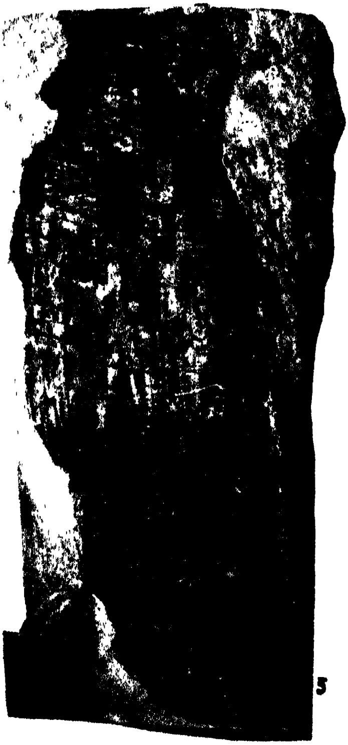

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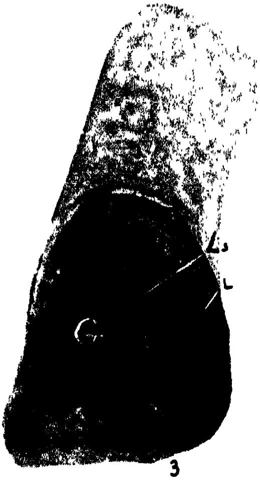

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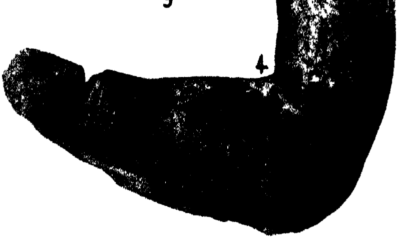

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Plate 15.

Fig. 1. *Agria gherzii* Palmer, new species, p. 78.

Posterior side; slightly reduced. Note shallow flutings and slightly convex upper valve.

Syntype, No. 2186 (C.A.S.); Paso del Rio, Colima, Mexico, Cenomanian

Fig. 2. View of upper valve of same specimen from above.

Note concentric structure.

a. Vermiculate structure on periphery of upper valve.
b. Upper edge of lower valve.
S. Exhalant siphonal area.
I. Interband
E. Inhalant siphonal area.
I. Pedal fold.
P. Posterior fold

Fig. 3. Vertical section of same specimen.

a. Upper valve.
b. Lower valve.
o. Large accessory cavity of upper valve. This occupied a large portion of the body cavity *G*.
mp Sunken myophore pit of lower valve
m'p'. Pendant myophore of upper valve.

Fig. 4. Longitudinal section of another specimen, 2″ high.

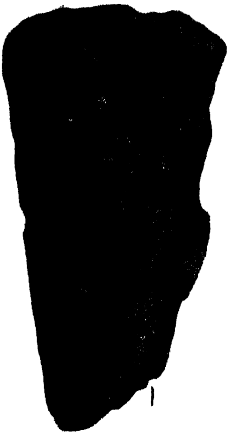
f Funnel plates.
G. Body cavity.

Note concave septa of body cavity.

Syntype, Palmer collection, Paso del Rio, Colima, Mexico; Cenomanian

Fig. 5. Horizontal section of specimen shown in fig. 4. Enlarged twice.

Note edges of vertical radial plates and of undulating concentric lines which are the edges of the funnel plates. The area below *G*, shaded with oblique lines is obviously on the specimen but may be due to mineralization and not to organic structure.



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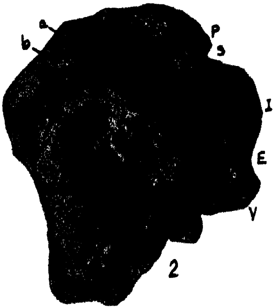

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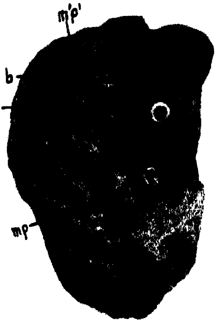

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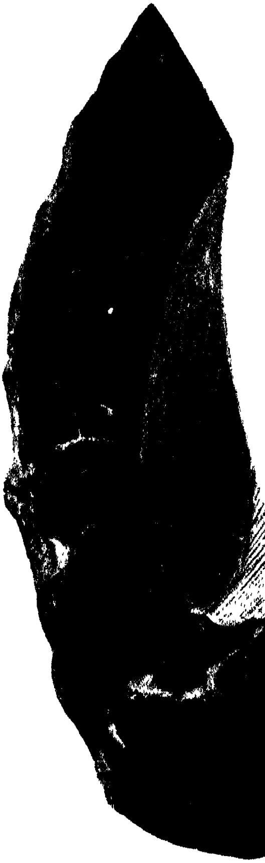

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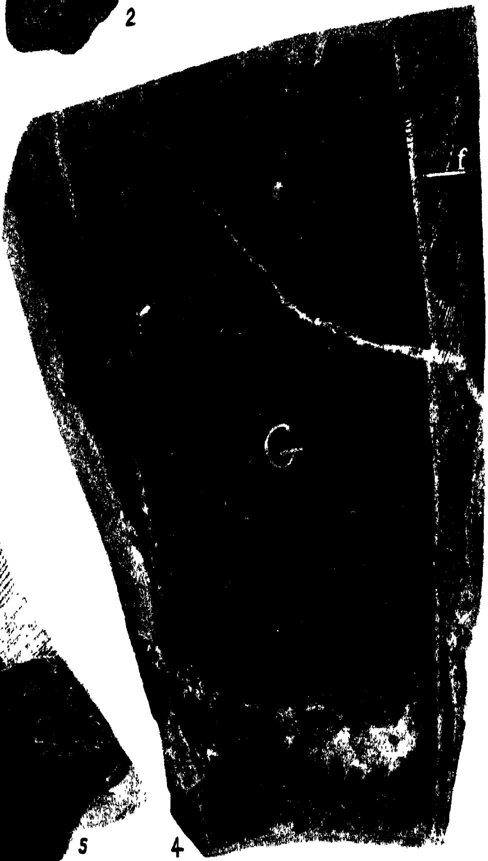

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Plate 16.

Fig. 1. *Radiolites robusta* Palmer, new species; p. 80.

Lower valve, ventral side, enlarged 1½.

V. Pedal fold.
E. Inhalant siphonal area.
I. Interband.
S. Exhalant siphonal area.
P. Posterior fold.

Note well defined growth stages and heavy square interband. The growth stages turn sharply upward in crossing *E* and *S*. Note edges of funnel plates at *f*.

Syntype, No. 2182 (C.A.S.), Huescalapa, Jalisco, Mexico, Turonian

Fig. 2. View of chalice of the same specimen, natural size. For explanation of *P*, *S*, *I*, *E* and *V*, see fig. 1.

Fig. 3. Vertical section of another specimen showing flat upper valve, *a*, with high almost vertical border.

Syntype, No. 2181 (C.A.S.), Huescalapa.

Figs. 4-11. *Radiolites perforata* Palmer, new species, p. 81.

Figures 8, 9 and 11 natural size, the others slightly reduced. All specimens from Huescalapa, Jalisco, Mexico, Turonian. Fig. 4, view of ventral side.

Syntypes, No. 2183, 2181 (C.A.S.)

See fig. 1 for explanation of *I*, S and *P*.

Fig. 5. Anterior side of specimen shown in fig. 4.

Fig. 6. Exterior dorsal side of another specimen.

Fig. 7. Interior dorsal side of specimen shown in fig. 6.

L. Ligamental spur.
e. Upper edge of inner shell layer. The upper valve rests on this flange. The part of the valves above the flange is called the chalice.

Fig. 8. Vertical section showing flat upper valve, *a*, with wide, elevated margin.

e. Upper edge of inner layer of lower valve (cf. fig. 7).

Note portion of pendant myophore-dental apparatus of upper valve.

The oval form in the chalice of the upper valve is a foreign sessile organism.

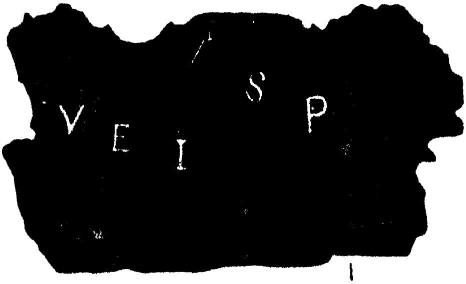
Fig. 9. Vertical view into chalice.

b. Edge of flat upper valve.
m. Edge of wide, flaring, elevated margin of upper valve. This closely fits into the undulations of the chalice of the lower valve.
p. Perforation in upper valve.

Fig. 10. Vertical view into chalice of the two valves.

p. Perforation in upper valve.

Fig. 11. Ventral-posterior view of young specimen. The foliaceous structure has not yet appeared.



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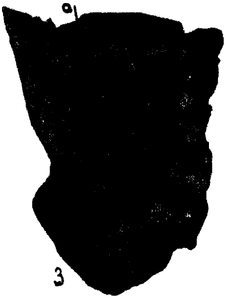

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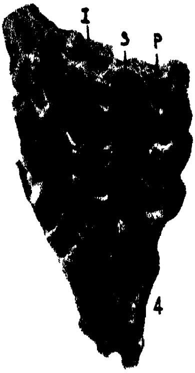

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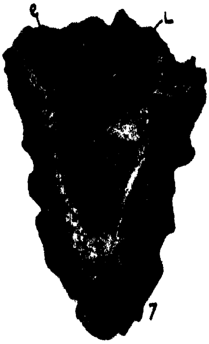

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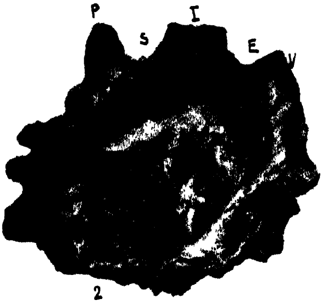

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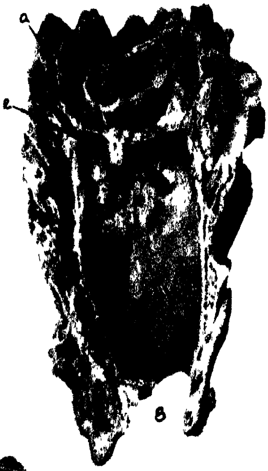

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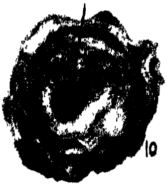

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Plate 17.

Fig. 1. *Radiolites perforata* Palmer, new species; p. 81.

View of posterior side of specimen shown on Pl. 16, fig. 8, natural size.

Huescalapa, Jalisco, Mexico; Turonian.

Fig. 2. *Radiolites inflata* Palmer, new species; p. 83.

Slightly reduced.

a Inflated upper valve.

Note absence of chalice.

Holotype, No. 2185 (C.A.S.); Huescalapa, Jalisco, Mexico, Turonian.

Fig. 3. View of top of engaged valves of specimen shown in fig. 2.

For explanation of *P*, *S*, *I*, *E* and *V* see Pl. 16, fig. 1.

Fig. 4. *Radiolites inflata* Palmer, new species; p. 83.

Anterior view of another specimen; slightly reduced.

Fig. 5 *Sphaerulites* species, p. 83.

Lower, fixed, right (*β*) valve; slightly reduced.

View of upper surface of valve.

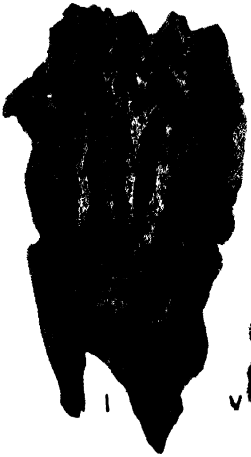
Note small rounded beekite bodies.

Huescalapa, Jalisco, Mexico, Turonian

Figs. 6-8 *Palus corrugatus* Palmer, new species; p. 33.

Dorsal views of specimens figured on Pl. 5, figs. 2-5, natural size. The ligamental groove, *L*, is exposed in figs. 6 and 7

Syntypes, Nos. 2156, 2157 (C.A.S.); Paso del Rio, Colima, Mexico; Cenomanian.



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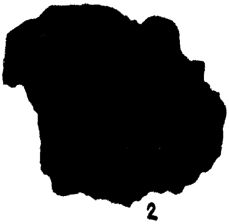

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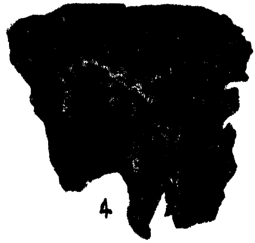

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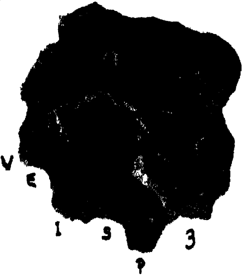

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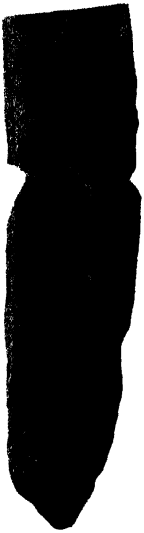

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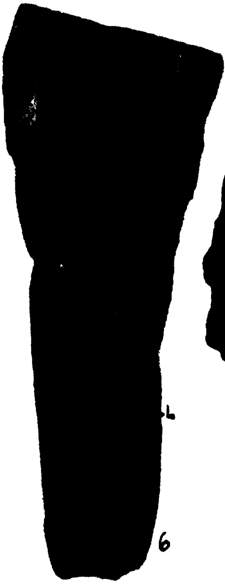

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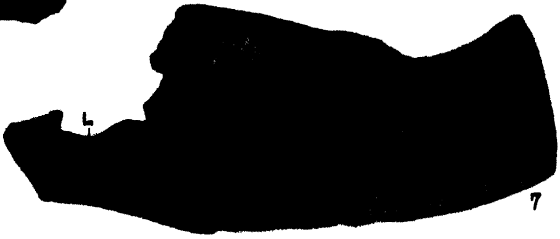

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PLATE 18

Fig. 1. *Diceras arietina* Lamarck

Upper Jura of France.

The umbos turn forward and outward, forming a spire

The shell was attached by the right valve.

Fig. 2. *Toucasia.*

Neocomian of Germany.

Upper side

a. Semi-operculate upper valve.

Fig. 3 *Requienia ammonia* (Goldf.).

Urgonian of France.

a. Beak of coil of lower valve by which the shell was attached

b. Operculate upper valve

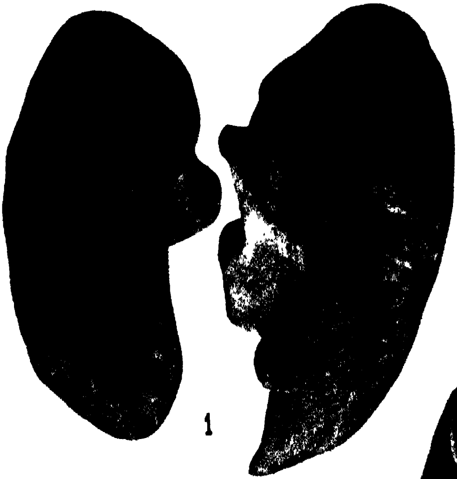
u. Line of union of valves.

Fig. 4. *Chama pellucida* Sowerby

Normal form, attached by left valve.

Fig. 5. The same

Inverse form, attached by right valve



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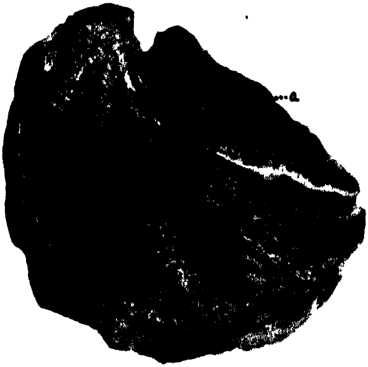

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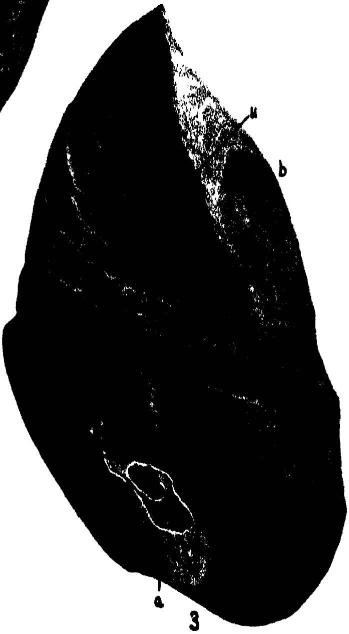

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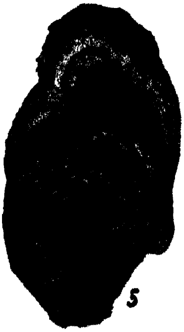

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STUDIES ON MARINE OSTRACODS

PART II

External Morphology of the Genus Cythereis with Descriptions of twenty-one New Species

BY
TAGE SKOGSBERG
Hopkins Marine Station, Pacific Grove, California

SAN FRANCISCO
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AUGUST 24, 1928

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STUDIES ON MARINE OSTRACODS, PART II

EXTERNAL MORPHOLOGY OF THE GENUS CYTHEREIS, WITH DESCRIPTIONS OF TWENTY-ONE NEW SPECIES

BY
TAGE SKOGSBERG
Hopkins Marine Station, Pacific Grove, California

PREFACE

When, in 1920, my "Studies on Marine Ostracods" was in the press, there were fairly strong reasons to suppose that my investigations of the marine Ostracods would be continued. So, "Part I" was added to the title of the paper. Many scientific treatises with this appendage to their titles stand as the lone representatives of series planned and hoped for by their optimistic authors; only to show how frequently aspirations in the field of science are shattered by unforeseen circumstances. "Ut desint vires, tamen est laudanda voluntas" . . . Mine is another example of this recurrent necessity to desert early aspirations for new fields of activity.

Shortly after the publication of the paper mentioned above, I was granted a traveling scholarship from the C. F. Liljewalch's Fund (of the University of Uppsala, Sweden) to continue, for a period of six months, my studies at the Hopkins Marine Station of Stanford University, Pacific Grove, California. Monterey Bay, on which the Hopkins Marine Station is located, is very rich in Ostracods, as well as in marine life generally. Indeed, it is undoubtedly one of the richest collecting places to be found in the proximity of a scientific institution. I collected in this bay a large number of species of Ostracods, nearly all of which were new to science. However, when, at the end of the stipulated six months, I determined to remain on the west coast of America, it became necessary for me to take up new lines of research. During the last five years I have been working largely on problems bearing on commercial fisheries and on the marine dinoflagellates. Meanwhile my studies on the Ostracods had to be discontinued. When at this late date "Part II" of my "Studies" appears, it has not the form originally planned. It is, on the contrary, but a part of a fairly large monographic treatment of the suborder *Podocopa,* extracted in order to preserve at least some of my results.

This paper contains an account of the external morphology of the genus *Cythereis* and the descriptions and the classification of some new species of this genus. General discussions have been postponed to a future contribution which I still hope to be able to issue.

Five of the twenty-one new species described in this paper were taken at or near Pacific Grove, California, and were examined and described at the Hopkins Marine Station. The remaining species were taken in the Antarctic regions either by the Swedish Magellan Expedition, 1896, or by the Swedish Antarctic Expedition, 1901-03. The Antarctic material was treated largely at the Swedish State Museum at Stockholm, where, due to the kind interest of Professor H. Théel of that Institution, a skilful artist, Mr. G. Liljevall, was placed at my disposal. Mr. Liljevall is responsible for most of the figures of the plates appended to this paper. All the text figures were drawn by the author.

A part of the material on which this paper is based is deposited with the Swedish National Museum (Riksmuseum), Stockholm, part in the Museum of the California Academy of Sciences.

It is a pleasure to use this opportunity to thank the following men for their help in the preparation of this work: Professor H. Théel (for whom *Cythereis théeli* is named), Professor T. Odhner, and Dr. N. Odhner, of the Swedish State Museum, Stockholm; Mr. G. Liljevall, also attached to that institution; and Professor W. K. Fisher, the Director of the Hopkins Marine Station, Pacific Grove.

Hopkins Marine Station of Stanford University,
Pacific Grove, California, November, 1926.

Family CYTHERIDÆ Baird (1850)

Subfamily Cytherinæ G. O. Sars (1925)

Genus **Cythereis** (T. R. Jones, 1849) Baird (1850)

DIAGNOSIS

Shell: Thick, with strong calcareous incrustation; surface frequently with more or less elaborate sculpture; sculpture as well as shape of shell highly variable. Muscle spots hard to detect, usually rather numerous, apparently always more than four. Inner line at a moderate distance from and subparallel to margin of shell; line of concrescence ("Verwachsungslinie") either coincides entirely with inner line, or these lines are separated only along a short distance inside anterior margin of shell. Marginal pores frequently numerous, especially anteriorly and antero-ventrally where they are very closely set; all or nearly all simple, and most of them somewhat widened either near their middle or near margin of shell. Selvage narrow or of moderate width, hard to detect. Hinge with two strong terminal teeth on right valve, one anterior and one posterior, and with one strong tooth on left valve located just behind anterior tooth of right valve; teeth fit into sockets on opposite valves; between teeth usually a more or less developed ridge fitting into a groove on opposite valve. Eyes usually present, composed of two portions which may be lodged in special cavities of the shell.

First antenna: Fairly strong, either five- or six-jointed; second joint with one bristle, postero-distal in position; third joint with one bristle, antero-distal in position; all bristles of moderate length to rather short, at least four of those on the three to four distal joints strong and claw-like.

Second antenna: Strong and four-jointed (one protopodite joint and three endopodite joints); exopodite sometimes well-developed in both sexes, sometimes well developed in ♂, but reduced in ♀, sometimes reduced in both sexes; first endopodite joint with one bristle; second endopodite joint, besides postero-distal bristles, with two bristles on anterior side and three on posterior side; distal joint with three claw-like bristles.

Mandible: With a strong, toothed masticatory process: and with a comparatively large palp, the three proximal joints of which may be completely merged; distal joint at least twice as long as its basal height. On ventral side of first and second endopodite joints, there are three long, thick, and curved bristles, each furnished with two longitudinal rows of fairly long hairs; these bristles at least as long as total dorsal length of first and second endopodite joints. Second endopodite joint with eight dorso-distal bristles, most of which are placed on a verruciform process.

Maxilla: Epipodial appendage rather large, with about 16 bristles; at base of its dorso-anterior bristle, there is a rather small, rounded, lobe-like projection with a dense coat of rather long hairs; no bristles of this appendage directed toward the mouth and none is "aberrant." With three well developed endites, at most about twice as long as high, each with about seven or eight distal bristles. Endopodite two-jointed, proximal joint rather large, distal joint small.

Fifth, sixth, and seventh limbs: Long and slender, but at the same time rather powerful; four-jointed, all joints well separated and differentiated; always with a postero-proximal bristle on the protopodite and with a ventero-distal bristle on the first exopodite joint; fifth limb with two bristles at knee, sixth and seventh with but one at corresponding place; proximally to knee, anterior side of protopodite has two bristles, the proximal of which may be vestigial in seventh limb.

Furca: Small, with two to three rather short bristles.

Almost exclusively marine, occurring all over the world and at all depths.

REMARKS

In examining a fairly large number of species and genera of the suborder *Podocopa,* I established two fundamental facts. First, generally speaking, most organs are subject to but slight variations within each genus. Second, when variations do occur, they are not limited to one or a few organs, but different organs vary in different species. In order to avoid too much repetition in the descriptions of the species under these circumstances, it seemed best to adopt the principle applied to the genus *Conchoecia* in my "Studies on Marine Ostracods, Part I," 1920; i.e., to present in the descriptions of the genera and subgenera what might be termed the "normal types" of the various organs. When a character is not noted in the description of a species, it thus means that in this species the character in question agrees with the "normal type" of the genus or subgenus. In most genera it is sufficient to give figures of all the organs in the case of one species only. The descriptions of the remaining species can conveniently be made in the form of comparisons with this representative form. In my presentation of the genus *Cythereis, Cythereis (Cythereis) montereyensis* sp. nov. was chosen as the typical representative.

It should be noted that for practical reasons the directions of the parts of the various organs, as given in this paper, always refer to the organs as they appear under the cover-glass.

Cythereis was established as a subgenus by T. R. Jones in his "Monograph of the Entomostraca of the Cretaceous Formation of England," 1849. It was thus originally founded exclusively on the shells of fossil forms. According to Jones, this subgenus would differ from the genus *Cythere* mainly in the following respects: The shell has an "almost regularly oblong shape," while in *Cythere* it is "irregularly oval and gibbous." However, even though the dorsal and ventral margins tend to be sub-parallel, the dorsal margin has a posterior slope. "The superior border, however, especially in the left (larger) valve, trends upwards as it approaches its anterior extremity, making at its junction with the anterior border a more acute angle than that formed by the junction of the anterior and ventral borders, and thereby leaving a greater space between the anterior hinge and the ventral margin than between the same margin and the posterior hinge." It thus appears to be rather the straight course of the dorsal margin than the sub-parallelism of the dorsal and ventral margins that Jones considered to be important. With regard to the sculpture of the surface of the shell, Jones writes as follows: "On the valves three eminences or tubercles are more or less strongly developed; one rather anterior to the centre, which is very characteristic of this section . . . and one at each angle formed by the junction of the posterior with the superior and inferior borders. From each of these last-mentioned tubercles a ridge generally arises, which is continued more or less uninterruptedly around the edge of the valve."

The species included by Jones in the subgenus *Cythereis* are very different from each other and, taken as a whole, do not well agree with the characterization of the subgenus. Thus while in *Cythereis quadrilatera*, *C. ciliata*, and *C. cornuta*, the dorsal and ventral margins are sub-parallel, in *C. triplicata* the dorsal margin slopes so abruptly posteriorly that the posterior margin is nearly suppressed. Also the shape of the dorsal margin is distinctly variable. In regard to the sculpture of the surface of the shell, Jones's species also exhibit striking differences. In *C. interrupta* the surface is nearly smooth, "pitted like the surface of a thimble" and without or with but slightly developed ridges. In *C. gaultina* "the whole surface of the valve exhibits a beautiful arrangement of slightly raised network." In *C. ciliata* the surface is covered with granulations and spines and has a strongly developed central tubercle and great keels.

The question as to whether all the species included by Jones in *Cythereis* belong to one natural systematic unit can not be settled as yet but probably has to be answered in the negative. Furthermore, it does not seem advisable at this time to select any one of the forms described by him as the type of this unit. An extensive study of recent forms and a careful comparison between these and Jones's species ought to precede this choice.

W. Baird ("Natural History of the British Entomostraca," 1850), who was the next to treat *Cythereis*, elevated this subgenus to generic status and gave it the following diagnosis: "Animal unknown. Carapace valves or shell of an almost regular oblong shape, the dorsal and ventral margins lying nearly parallel to each other. Surface of a very irregular appearance, being wrinkled, ridged, and beset with tubercles, and crenulated or strongly toothed on the margins." Baird thus places emphasis on the roughness of the surface of the shell.

G. O. Sars, 1865, who was the first to examine the appendages of recent members of this genus, emphasized the same characteristics of the shell as did Baird. In regard to the appendages the following characteristics were given by this investigator: The first antennæ are "vero sæpius distincte 6 articulatæ." In the adult females the exopodites of the second antennæ are "brevissimo et obtuso instructae." The palp of the mandible is elongated, curved, and distinctly four-jointed; the distal joint is long and narrow. The first endopodite joint has two, the second endopodite joint has one, long, curved ventral bristles furnished with hairs. The epipodial appendage has five bristles of which two are short. In the epipodial appendage of the maxilla, one bristle is situated somewhat apart from the remaining ones. The furca has two or three bristles. This diagnosis evidently agrees more closely with my diagnosis of the subgenus *Pseudocythereis* than with my diagnosis of the subgenus *Cythereis*. Especially noteworthy in this connection is the number of bristles of the epipodial appendage of the mandible. Also, the first antenna is described as six-jointed. In regard to the latter character, however, it should be noted that not fewer than four of Sars's twelve species had five joints in this appendage (*Cythereis villosa, emarginata, angulata,* and *abyssicola*).

In his "Monograph of the Recent British Ostracoda," 1868, G. S. Brady rejects the genus *Cythereis* and joins it with the genus *Cythere*. This investigator writes as follows: "In the first place the characters taken by that author [G. O. Sars] as the ground of generic distinction seem to me inadequate; secondly, four of our British species, *C. albomaculata, convexa, rubida,* and *pulchella,* present intermediate characters, and could not be included under either of the genera as defined by Sars. . . . If the characters here ascribed to *Cythereis* could have been found to be uniformly coincident with the quadrangular and rugose forms of carapace for which the genus *Cythereis* was originally proposed, or even if they could have been applied with precision to any group, without respect to shell-structure, they might perhaps, though dubiously, have been allowed to form the basis of a distinct genus; but seeing that we have forms distinctly partaking of the characters of both genera, there seems no reasonable course but that of uniting the two under one name." *Cythereis albomaculata* would have the shell and the exopodite of the second antenna similar to the genus *Cythere,* but its mandible and furca would agree with *Cythereis*. *Cythereis convexa* would resemble *Cythere* in the case of the shell and *Cythereis* in the second antenna and the mandible. *Cythereis rubida* approaches *Cythere* in the shape and structure of the shell, while all its appendages agree with *Cythereis*. *Cythere pulchella* is too incompletely known to be considered in this connection. The outline of its shell recalls the genus *Cythereis;* the exopodite of the second antenna is well developed in males and females. Also in his later papers (e.g., in his monograph of the Ostracods collected by the Challenger Expedition), Brady maintains this attitude.

In the present paper I have adopted G. W. Müller's (1894) decision that the genus *Cythereis* ought to be maintained, and that it is not even very closely related to the genus *Cythere*. Indeed, it is structurally closer to the genus *Cytherideis* Jones than to *Cythere*. The only thing demonstrated by G. S. Brady's criticism is that the shape and structure of the shell and the development of the exopodite of the second antenna are not characteristic of the genus *Cythereis*. In the case of other structural features, e.g., of the mandible, no intermediate forms are known to occur. The structure of the mandible is, indeed, the most characteristic feature of the genus *Cythereis*. It is a peculiar fact that this characteristic has been overlooked by so careful a worker as G. O. Sars who in his latest paper (1925) assigns a typical member of the genus *Cythereis*, viz., *C. albomaculata* (Baird), to the genus *Cythere* and omits the structure of the mandibular palp from the diagnosis of the latter genus.

The genus *Trachyleberis* established by G. O. Brady, 1898 (p. 444), undoubtedly is referable to the genus *Cythereis*, as conceived by G. W. Müller and me; compare G. W. Müller, 1912, page 336. On the other hand, I am not able to follow G. W. Müller (1912, p. 336) when he includes the genus *Cytheridella* (Daday, 1905, p. 261) in *Cythereis*. *Cytheridella* differs so profoundly from *Cythereis* in most respects that even a close relationship between these two genera appears very questionable.

There is a possibility that some of the species described as new in the present paper have been established previously. The reasons for this uncertainty are that G. S. Brady has established a fairly large number of species of the genus "*Cythere*" based on material from the Tierra del Fuego and from the Falkland Islands, i.e., from two of my most important localities; and that these species are described and figured so superficially that their certain identifications are excluded at the present time. If Brady's type material still exists, some of his species might be found to be identical with some of mine. However, until a reexamination of these forms of Brady has been carried out, it does not appear to be advisable to attempt their identification.

The species of Brady referred to in the last paragraph are as follows:

From **Tierra del Fuego:**

Cythere contracta G. S. Brady, 1870, p. 201, Pl. XXVII, figs. 5, 6. This has the outline of the shell similar to that of *Cythereis (Cythereis) mesodiscus,* but the surface appears to lack pronounced structural differentiation. It is classified by G. W. Müller (1912) under the heading "Cytheridarum genera dubia et species dubiae." Many species have about the same outline of shell.

Cythere convexa var. *meridionalis* G. S. Brady, 1870, p. 234, Pl. XXX, figs. 11-13. In this species the outline of the shell recalls *Cythereis (Procythereis) radiata.* The agreement is, however, not complete, and the structure of the surface is uncertain. G. W. Müller (1912) writes this name as a possible synonym of *Cythereis convexa.* A fairly large number of species have the same outline of shell as this form.

Cythere cuboidea G. S. Brady, 1870, p. 201, Pl. XXVII, figs. 13, 14. This species does not show any distinct resemblance to any of my species of *Cythereis.* It is classified by G. W. Müller (1912) under "Cytheridarum genera dubia et species dubiae."

Cythere magellanica G. S. Brady, 1870, p. 201, Pl. XXVII, figs. 19-22. Of this species Brady figures two specimens, the male and the female. The male (figs. 19, 20) recalls *Cythereis (Cythereis) recurvirostra;* the female (figs. 21, 22), *Cythereis (Procythereis) iganderssoni.* In all probability Brady has mixed two species. The similarities are not striking enough to justify identification. G. W. Müller (1912) records this form under "Cytheridarum genera dubia et species dubiae."

Cythere margollei G. S. Brady, 1870, p. 200. Of this species not even the shell is figured; and so I refrain from any suggestions as to its relationships. Regarded by G. W. Müller (1912) as an uncertain member of *Cythereis.*

Cythere propinqua G. S. Brady, 1870, p. 233, Pl. XXX, figs. 6, 7. This form does not show any distinct similarity with any of my species. The outline of the shell approximates the one characteristic of the species of the *Discophora* group. Recorded by G. W. Müller (1912) among the "Cytheridarum genera dubia et species dubiae."

Cythere reussi G. S. Brady, 1870, p. 153, Pl. XVIII, figs. 9, 10; 1880, p. 74, Pl. XIV, fig. 2. Undoubtedly based on two different species. Neither of them resembles any of the forms described by me. Regarded by G. W. Müller (1912) as an uncertain member of *Cythereis.*

Cythere shorelli (according to G. W. Müller, 1912, a lapsus pennæ for *thorelli)* G. S. Brady, 1870, p. 234, Pl. XXX, figs. 14, 15. Recalls somewhat *Cythereis (Cythereis) mesodiscus,* but is distinctly higher relatively. Classified as an uncertain member of the genus *Cythereis* by G. W. Müller (1912).

Cythere subquadrata G. S. Brady, 1870, p. 233, Pl. XXX, figs. 8-10. The outline of the shell seen laterally, but not from below, recalls the members of the *Ephippiata* group. The surface of the shell, however, appears to lack distinct areolation. G. W. Müller (1912) puts it under the heading "Cytheridarum genera dubia et species dubiae."

Cythere zurcheri G. S. Brady, 1870, p. 200. Of this species no parts are figured, and so no suggestions are ventured. Regarded by G. W. Müller (1912) as an uncertain member of *Cythereis.*

Cythere scintillulata G. S. Brady, 1880, p. 62, Pl. XIV, fig. 3. Does not at all resemble any of the species established by me. Classified by G. W. Müller (1912) as uncertain to genus as well as to species.

From the **Falkland Islands:**

Cythere falklandi G. S. Brady, 1880, p. 65, Pl. XII, fig. 6. Does not show any similarity to any of the species described in the present paper. Considered to be uncertain to genus as well as to species by G. W. Müller (1912).

Cythere fulvotincta G. S. Brady, 1880, p. 67, Pl. XIV, fig. 5. Does not resemble any of my species. According to G. W. Müller (1912) of the same status as *C. falklandi.*

Cythere impluta G. S. Brady, 1880, p. 76, Pl. XVI, fig. 3, Pl. 26, fig. 6. Two distinct species. See remarks under *Cythereis (Cythercis) théeli.* An uncertain member of *Cythercis,* according to G. W. Müller (1912).

Cythere mosleyi G. S. Brady, 1880, p. 64, Pl. XII, fig. 5. Does not resemble any of my species. Uncertain to genus and species, according to G. W. Müller (1912).

As will be seen from the above summary, some of my species resemble forms previously taken at the same locality, while the majority do not. G. S. Brady has established a great many more species of *"Cythere"* from other localities, described and figured just as superficially as those discussed above. Of course, there is a possibility that some of these are identical with some of mine. However, the probability is fairly small. Generally speaking, the great majority of the species of this multiform genus are described so unsatisfactorily that certain identification can not be made. A fundamental revision of this genus must necessarily be carried out before the development of our knowledge in this field can proceed on a firm basis.

The first attempt at a subdivision of this genus was carried out by G. W. Müller (1894), who established three groups of species on the basis of the structure of the surface of the shell. The first group is characterized by having pits on the surface of the shell but no processes on the ribs and no distinct longitudinal ribs. Furthermore, the females of the members of this group have the exopodite of the second antenna short. In all probability the first antenna is five-jointed (figured for one species only, viz., *Cythereis convexa).* Thus the species of this genus belong to the subgenus *Cythereis.* In the second group the ribs separating the pits have knob-like processes. In other respects the shell should have the same characteristics as in the first group. Only two species are assigned to this group. Although these show a certain similarity in the structure of the shell, their penes are so different that a close relationship appears improbable. At least in one of the two species the first antenna is six-jointed. The exopodite of the second antenna is reduced in size in the males, which indicates that these species do not belong to any of the three subgenera established in the present paper. The third, and last, group is characterized by having "not more than four longitudinal ribs" on the shells; besides these, the shell may have pits and processes, or it may be smooth. This group, which comprises six species, appears to be distinctly heterogeneous. The development of the exopodite of the second antenna is variable. The first antenna appears always to be six-jointed. Besides members of these three groups, G. W. Müller found four species, viz., *Cythereis prava, lineata, dentata,* and *teres,* which do not approach any of the groups but occupy a more or less isolated position. Of these species, *C. dentata* appears to be fairly closely related to *C. falcata,* judging by the structure of the penis.

A subdivision of the genus *Cythereis* on the basis of the shape and structure of the shell is, generally speaking, impossible. The best illustration of this statement is afforded by my subgenus *Procythereis;* compare, for instance, *Cythereis (Procythereis) iganderssoni* with its heavily developed ventral main ridge and heavy reticulation, and *C. (P.) polita*, which almost completely lacks main ridges and the surface of which is nearly smooth, being ornated only with minute pits. The subdivisions must, on the contrary, be based on the structure of the appendages and of the penis. Especially the structure of the penis appears to be significant. Indeed, just as in several other groups of Arthropods, this organ appears to have been the seat of the initial morphological changes leading to speciation. Unfortunately, the morphological interpretation of the structural complexities of this organ is still uncertain. To carry out the homologies of its different parts will probably prove the most fascinating and fruitful morphological problem that the Ostracod group has to offer.

It has not appeared advisable to attempt at the present time a classification of the species of this genus described in previous papers. Nearly all of these species, even those treated by G. W. Müller, are described too superficially to allow a well-founded opinion about their morphological and evolutionary relationships. As I have noted at another place in this section, a thorough revision of the members of this genus is imperative.

Subgenus Procythereis, new subgenus

Description:

Shell: With the same characteristics as in the subgenus *Cythereis.*

First antenna: Without sex dimorphism. The normal type is about the same as in the subgenus *Cythereis;* with five joints. Length of fourth joint rather variable; within each species, however, fairly constant. (With regard to the measurements of the length of this joint given in the descriptions of species, see the footnote under the description of this appendage in the subgenus *Cythereis.)* The most striking differences from the normal type of the subgenus *Cythereis* are found in the short latero-distal claw of the fourth joint. This claw points in about the same direction as the distal joint and is relatively long, being in most cases about as long as the distal joint, or but slightly shorter (text fig. II, 3 of *C.* [*Procythereis*] *iganderssoni).* The relative lengths and the types of the remaining bristles are about the same as in the subgenus *Cythereis.* A small spine is usually found at the bases of the narrow bristles issuing in front of the two long claws of the fourth joint. The pilosity is about the same as in the subgenus *Cythereis.* The hairs on the two distal joints, however, seem in most cases to be rather weakly developed.

Second antenna: Without or with fairly slight sex dimorphism. The normal type is about the same as in the subgenus *Cythereis,* but the exopodite of the female is of approximately the same size and shape as in the male.

Mandible: Without or with very slight sex dimorphism. The normal type is very similar to that of the subgenus *Cythereis.* The following differences are, however, characteristic of the species described in this paper. Masticatory joint: The next to the anterior tooth, which is single or paired in the subgenus *Cythereis,* seems always to be paired. Fifth pair of teeth small and in most cases represented by a single tooth. Behind the fifth pair of teeth follow a bifurcate, peg-like tooth; a narrow, weak, simple or slightly bifurcate tooth, sometimes almost absent; and a short bristle. The notch at about the middle of the posterior side of this joint is usually less developed than in the subgenus *Cythereis;* and there is no rounded hump on the anterior side of the dorsal part of this joint. Epipodial appendage: This has two long bristles with long, fine hairs; furthermore, the vestigial bristle and the peg-like appendage are furnished with long hairs. Second endopodite joint: Of the two dorso-distal bristles which are short in the subgenus *Cythereis,* one is rather long in *Procythereis,* being about twice as long as in *C. (Cythereis) montereyensis;* the other usually a little longer than the end joint. These two bristles are usually non-annulated, and furnished with short, fine hairs or nearly naked. The two ventral bristles of this joint are situated somewhat more distally than in figure 9 of *C. (Cythereis) montereyensis.* On the inner side of the second protopodite joint, somewhat dorsally to the middle of the joint, there is, as a rule, a group of hairs.

Maxilla: This shows no sex dimorphism. The normal type is very similar to that of the subgenus *Cythereis.* The following differences are found in the species described in this paper. First endite: The rather strong bifurcate bristle in figure 13 of *C. (Cythereis) montereyensis* is usually furnished with several fairly long and rather powerful spines. Second endite: One bristle with long hairs, and seven with fine and more or less short ones. Third endite: Two bristles with numerous long hairs, four with short, fine hairs, and one with fairly strong spines. Palp: All the four dorso-distal bristles of the first joint are annulated; the three short ones with short hairs or hairs of moderate length; the long one in most cases with hairs of moderate length. On the lateral side of this joint there is a longitudinal, usually dense, row of fine hairs.

Fifth limb: Without or with rather slight sex dimorphism. Normal type: Similar to that of the subgenus *Cythereis,* but the shorter of the two bristles at about the middle of the anterior side of the protopodite is situated somewhat, though rather little, proximally to the other.

Sixth and seventh limbs: About the same as in the subgenus *Cythereis.* However, the short hairs on the outside of the protopodite seem to be absent or very slightly developed.

The chitinous support of the last three appendages, developed on the sides of the body, resembles in the main that in the subgenus *Cythereis.* It shows, however, rather great variations, even within the species, and seems not to be convenient to use in distinguishing the species.

Brush-shaped organ: About as in the subgenus *Cythereis.*

Penis: Of about the same fundamental type as in the subgenus *Cythereis.* A detailed description may conveniently be postponed.

The furca of the male and female, and the posterior part of the female body approximately as in the subgenus *Cythereis.* In the species examined by me, no transverse rows of spines were found near the bristle on the posterior extremity of the female body.

Lips: About the same as in the subgenus *Cythereis.* In the species described in this paper the A-shaped chitinous support above the upper lip has no cross-bar. The dorso-medial of the pairs of chitinous strips of the upper lip seems to be absent or is very weak.

The color of the chitin is about the same as in the subgenus *Cythereis.*

The type species of this subgenus is *Cythereis (Procythereis) torquata.*

Arrangement of the species: This subgenus may conveniently be divided into two groups, characterized by the shape and structure of the penis and by the course of the ductus in the genital verruca of the female. These two groups may be called the *Torquata* Group and the *Radiata* Group.

Torquata Group nov.

Cythereis (Procythereis) torquata and *iganderssoni,* and presumably also *C. (P.) robusta,* belong to this group.

C. (Procythereis) torquata, new species

Plate I, fig. 1; Plate IV, fig. 2; text fig. I.

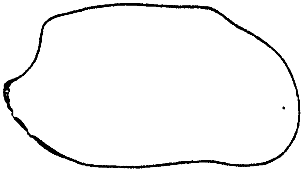
Description: Male—

Shell: The shells of the males examined by me unfortunately were broken. I am thus unable to give a description of them. However, judging by the fragments, the male shell has about the same shape as that of the female and the same characteristic sculpture of the surface.

First antenna: Relatively elongated; somewhat more slender than in *C. (Cythereis) montereyensis*. Proportions of the lengths of the joints about as follows:

I. $\frac{14}{17}$ II. $\frac{13}{9}$ III. $\frac{4}{4.5\text{–}5.0}$ IV. $\frac{11.5}{10.5}$ V. $\frac{3.5}{4}$

Third joint: Claw rather weak, its tip reaching to or slightly beyond point of attachment of proximal claw of fourth joint. Fourth joint: Proximal claw usually somewhat weaker than in text fig. VI, 5 of *C. (Cythereis) montereyensis;* almost straight, and generally slightly longer than posterior side of second joint. The narrow bristle in front of this claw is in most cases somewhat shorter than the claw, its length somewhat variable. The long distal claw of this joint about as long as posterior side of second joint and somewhat more than twice as long as distal joint, its type about same as in *C. (Cythereis) montereyensis.* The short latero-distal claw of this joint about as long as, or slightly shorter than distal joint and about as strong as bristle of second joint or slightly weaker. Distal joint: Claw about as long as long distal claw of fourth joint. Proportions of other bristles of this antenna about same as in text fig. VI, 5 of *C. (Cythereis) montereyensis.* Pilosity: A longitudinal, sometimes somewhat irregular, row of hairs of different lengths on both medial and lateral sides of first joint; hairs on anterior side of second joint scarcer than in *C. (Cythereis) montereyensis,* distal ones fairly long; hairs of the two distal joints very slightly developed, distal part of fourth joint and distal joint being practically naked.



Text fig. I. *Cythereis (Procythereis) torquata* n. sp., ♀, not type. Right valve from the side. Tierra del Fuego, Cape Valentyn. X39.

Second antenna: Type of protopodite and endopodite, and positions of bristles about same as in Plate XXXV, fig. 19,

G. W. Müller, 1894. Bristle of first endopodite joint often slightly weaker and shorter than in *C. (Cythereis) montereyensis*. Medial one of the three bristles at about middle of posterior side of second endopodite joint slightly shorter, the postero-lateral one slightly longer than in text fig. VII, 8 of the mentioned species; pectination of these two bristles of moderate strength or fairly weak. Proportions of the three end claws about same as in the mentioned figure, or the proximo-lateral one slightly shorter and weaker than proximo-medial one; pectination of these three claws weak. Pilosity: On medial side of protopodite a longitudinal row of hairs; on lateral side usually more or less developed scattered hairs.

Mandible: Masticatory joint: Anterior tooth single, as in all species of the subgenus *Cythereis;* spine next to posterior bristle of the pars incisiva well developed, but narrow and weak. Of the two short ventro-distal bristles of first endopodite joint, the ventral one generally somewhat longer than corresponding bristle in text fig. VII, 9 of *C. (Cythereis) montereyensis*. Hairs in row of hairs on medial side of second endopodite joint of moderate length.

Fifth limb: Of about same type as in *C. (Cythereis) montereyensis,* ♂, but exopodite slightly longer, when compared with the protopodite; first exopodite joint slightly longer than second, or the three exopodite joints are nearly subequal in length. Bristle on posterior side of protopodite rather thick but not swollen at base, about as long as third exopodite joint, and along its entire length furnished with a dense coat of hairs of moderate length; bristle of first exopodite joint somewhat shorter in specimens examined than in text fig. VIII, 14 of *C. (Cythereis) montereyensis;* end claw slightly longer than in this figure, and almost naked.

Sixth limb: Of nearly same type as in *C. (Cythereis) montereyensis,* ♂. The following differences are to be noted: Exopodite slightly longer, when compared with protopodite; proximal bristle on anterior side of protopodite joint slightly longer; bristle on posterior side of this joint of same type and relative length as the corresponding bristle of preceding limb; bristle on first exopodite joint of same type as in male of the mentioned species but somewhat shorter than second exopodite joint; end claw somewhat longer relatively and almost naked.

Seventh limb: This differs in the following respects from the corresponding limb in the male of *C. (Cythereis) montereyensis:* Exopodite somewhat longer, when compared with the protopodite, and first exopodite joint slightly longer relatively; long bristle at about middle of anterior side of protopodite about as long as this side; bristle on posterior side of protopodite somewhat shorter; contrary to this bristle of the two preceding limbs, it has the same narrow type as the anterior bristle; bristle of first exopodite joint slightly weaker.

Brush-shaped organ: Of subequal thickness throughout its entire length, three to four times as long as wide; distal bristles somewhat longer than stem; no row of short hairs detected.

Penis (Pl. IV, fig. 2): Right and left organs similar; vas deferens with spiral thickening; ductus ejaculatorius with a rather short and narrow free distal part, forming a characteristic coil; copulatory appendage strongly arched proximodorsally, almost straight or slightly sinuated ventrally, narrowly rounded to almost pointed distally.

Description: Female—

Shell (Pl. I, fig. 1): Length, 0.96-1 mm.; length: height, about 1.70-1.75 :1. Seen from the side: Left valve: Greatest height at about middle; dorsal half of anterior margin somewhat more flattened than in most species of the subgenus *Cythereis,* its ventral half very finely crenulated; posterior extremity of valve produced somewhat below middle in a distinct, broadly and irregularly rounded beak which is furnished with about three to six rather strong, blunt calcareous teeth. Anterior part of dorsal margin of valve sub-horizontal, nearly straight, or slightly arched or sinuated; posterior part of this margin sloping gently backwards and forming with the somewhat sinuated dorsal part of posterior margin a broadly rounded but conspicuous corner. Ventral margin slightly sinuated in front of middle, posteriorly gently and evenly arched, joining posterior margin without forming any corner. Right valve (text fig. I) differs from left mainly in the following respects: Anterior margin somewhat sinuated dorsally; dorsal part of posterior margin somewhat more sinuated, which makes postero-dorsal corner still more conspicuous. Seen from below, shell is about 1.9 times longer than wide, broadest at about middle, and of about same type as in *Cythereis kerguelensis*, G. W. Müller, 1908, p. 139. Sculpture of surface: Ventral main ridge one-sided and very strongly developed along whole ventral margin which it does not cover when shell is seen from the side; it ends suddenly, forming a somewhat rounded to rectangular angle somewhat in front of posterior beak-like process of shell; no other main ridges developed. Dorsally to and along edge of ventral main ridge, there is a series of somewhat oblong, fairly large excavations; greater part of surface covered with numerous, rather small, more or less rounded, and mostly scattered excavations, the number, size, and density of which vary; anteriorly and posteriorly shell has closely-set, irregular excavations of moderate size. Most of the excavations of the surface are of moderate depth, some rather shallow. Along ventral half of anterior margin and along anterior part of ventral margin, there is about fifteen to twenty flattened, hyaline, leaf-like bristles, furnished with short, fine marginal hairs. No dark fields to be detected when shell is regarded by transmitted light (of course, with the exception of the ridge).

Fifth limb: Differs from that of male chiefly in the following respects: Bristle on posterior side of protopodite somewhat swollen at base and furnished with a dense coat of long hairs; bristle on first exopodite joint about half as long as next joint, or even somewhat longer.

Sixth limb: Differs from that of male in the following respects: Bristle on posterior side of protopodite almost of same type as in the case of fifth limb of female; bristle on first exopodite joint of about same type and length as in *C. (Cythereis) montereyensis*, ♀, or somewhat longer.

Seventh limb: Differs from that of male chiefly in the following respects: Bristle of first exopodite joint somewhat longer, about as long as second exopodite joint or slightly shorter, and almost as strong as in text fig. VIII, 16 of *C. (Cythereis) montereyensis;* the claws of this and the two preceding limbs sometimes somewhat shorter than in male, being about as long relatively as in *C. (Cythereis) montereyensis.*

Genital verruca and posterior part of body as in *C. (Procythereis) iganderssoni.*

Remark: Two mature males and three mature females examined.

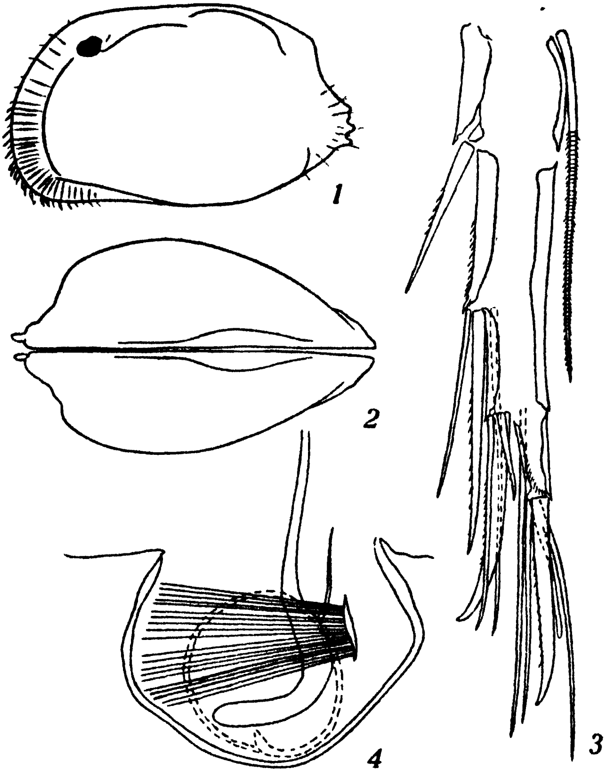
Habitat: **Tierra del Fuego, Cape Valentyn**; 12.III.1896; depth, 270 m.: Two females (S.M.E., 1896). **Tierra del Fuego, Puerto Condor** (type-locality): Two mature males and two mature females (S.M.E., 1896).

C. (Procythereis) iganderssoni, new species

Plate I, fig. 2; text fig. II.

Description: Female—

Shell (Pl. I, fig. 2; text fig. II, 1): Length, about 0.87 mm. (This was the length of one of my two specimens. The shell of the other specimen was somewhat shorter; it was, however, soft and evidently somewhat shrunk, its original length thus being impossible to state with full certainty.) Length: height, about 1.65:1; length: width, about 1.63:1. Seen from the side, of about same shape as in *C. (Procythereis) torquata*, ♀. Seen from below (text fig. II, 2): Ovate, widest somewhat behind middle; lateral contours (=the edge of main ventral ridge), evenly convex, converging gradually towards anterior extremity and fairly abruptly posteriorly; anterior extremity rather well pointed to narrowly rounded; posterior one beak-like, posterior parts of lateral contours being somewhat sinuated. End view almost equilaterally triangular, the three sides rather slightly to moderately convex and slightly irregular. Sculpture of surface: Ventral ridge one-sided (as is evident from the fact that the end view is equilaterally triangular) and very strongly developed; it continues along nearly entire length of shell and ends suddenly, forming a somewhat rounded to sub-rectangular angle, somewhat in front of posterior beak-like process of shell; its edge smooth and rather narrow. Just dorsally to and along the smooth edge of this ridge, there is a row of small, rounded to oblong pits of somewhat different sizes. Somewhat behind middle of shell, there is a dorsal ridge of moderate height, which ends in a broadly rounded angle somewhat in front of



Text fig. II. *Cythereis* (*Procythereis*) *iganderssoni* n. sp., ♀. 2, 3, 4, from type specimen.

1. Left valve from the side. ×52.
2. Shell from below; front end to the right. ×53.
3. Three distal joints of left first antenna, from lateral side. ×355.
4. Left genital verruca, from lateral side; dotted line indicates medial opening. ×800. Tierra del Fuego, Cape Valentyn.

postero-dorsal corner of shell. When right shell is seen from the side, the anterior part of edge of this ridge covers dorsal margin of valve; in left valve dorsal margin of valve is not covered by this ridge. Regarded from below (text fig. II, 2), each valve has a low ridge which runs rather close to the true ventral margin of valve; just in front of middle of valve, distance between margin of valve and this ridge is somewhat greater than near anterior and posterior extremities. Entire surface of shell honey-combed with numerous rather deep, sub-rotund to more or less angular excavations of somewhat variable number and arrangement. Ridges between excavations narrow and smooth, bottoms of excavations apparently smooth. In other respects shell of this species agrees with that of *C. (Procythereis) torquata.*

First (text fig. II, 3) and second antennæ, mandible, and fifth, sixth, and seventh limbs about as in *C. (Procythereis) torquata,* ♀. Bristle on posterior side of protopodite of seventh limb perhaps somewhat, though rather slightly, shorter relatively, about half as long as corresponding bristle in *C. (Cythereis) montereyensis.* Bristle of first exopodite joint of this limb about as long as second exopodite joint or slightly longer.

Genital verruca of about the type shown in text fig. II. 4; ductus sickle-shaped and rather wide within verruca.

Posterior end of body of about same type as in *C. (Cythereis) montereyensis,* ♀. No spines were detected in the neighborhood of bristle on posterior extremity of body.

Description: Male; unknown—

Remarks: This species is structually very close to *C. (Procythereis) torquata.* Indeed, in the females the only important differences between these two species are found in the shell. The differences exhibited by the sculpture of the shell are, however, so great that there hardly can be any doubt that we are dealing with two distinct species. An examination of the male of *C. (Procythereis) iganderssoni* will probably bring forth some important differences in the copulatory organs.

This species is named for Professor J. G. Andersson, a Swedish zoölogist and geologist, who was a member of the Swedish Magellan Expedition, 1895-1896, and of the Swedish Antarctic Expedition, 1901-03. It was mainly through Doctor Andersson's efforts that collections of ostracods were brought home by these expeditions.

Two mature females of this species were examined.

Habitat: **Tierra del Fuego, Cape Valentyn** (type-locality); 12.III.,1896; depth 270 m.: Two mature females (S.M.E.).

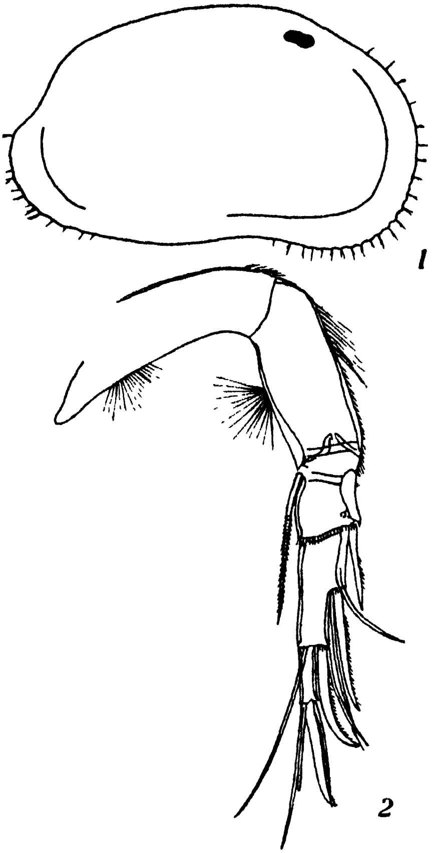
C. (Procythereis) robusta, new species

Plate I, fig. 3; text fig. III.

Description: Female—

Shell (Pl. I, fig. 3): Length, about 1.04 mm.; length: height, about 1.73:1. Seen from the side: Left valve: Greatest height at about middle. Ventral part of anterior margin somewhat crenulated. Posterior extremity of valve produced somewhat below middle in a very short, broadly and evenly rounded, beak without distinct teeth or crenulation; dorsal half of posterior margin almost straight. Dorsal margin of valve gently and evenly convex, sub-parallel to longitudinal axis of valve, forming with posterior margin a broadly rounded but distinct corner; ventral margin almost straight, slightly sinuated in front of middle. Right valve: Differs from the left mainly in the following respects: Anterior margin somewhat depressed dorsally; dorsal half of posterior margin distinctly sinuated; ventral margin somewhat more sinuated in front of middle. Seen from above of about the same shape as in *Cythereis kerguelensis,* G. W. Müller, 1908, p. 139. Sculpture of surface: Main ventral ridge developed along entire ventral margin of shell but very low. Surface covered with numerous small, rounded pits; on anterior and posterior extremities of shell pits arranged in groups of moderate size, surrounded by rather low ridges; some pits somewhat larger than others and contain a pore-canal with a bristle. Bristles as in *C. (Procythereis) radiata.* When regarded by transmitted light no dark fields are present.

First antenna (text fig. III, 2): Of about same type as in text fig. VI, 5 of *C. (Cythereis) montereyensis,* but fourth joint somewhat longer relatively, being about $\frac{7.5}{7}$, according to the scale used in the subgenus *Cythereis.* Latero-distal claw of fourth joint somewhat shorter than distal joint. Other bristles of this limb of about same types and relative lengths as in figure mentioned above but the long distal claw of fourth joint somewhat more curved and about twice as long as distal joint or slightly longer, and the narrow bristle in front of proximal claw of fourth joint somewhat shorter than claw. Pilosity: On medial side of first joint there is no longitudinal row of hairs; on proximal half of this joint, laterally, a longi-



Text fig. III. *Cythereis* (*Procythereis*) *robusta*, n. sp.
1. Right valve from the side, ♀, juvenis. ×64.
2. Left first antenna, from medial side, ♀, type. ×185.
S. A. E., Station 28.

tudinal row of fairly long hairs; pilosity of other joints about as in *C. (Procythereis) radiata.*

Second antenna: Shape and structure of protopodite and endopodite, and positions of bristles about same as in Pl. 35, fig. 19, G. W. Müller, 1894. In other respects this appendage agrees fairly well with the one in *C. (Procythereis) radiata.* The medial of the three bristles at about middle of posterior side of second endopodite joint with pectination of moderate strength; its type about same as that of postero-lateral of these three bristles.

Mandible: Of about same type as in *C. (Procythereis) radiata,* but anterior tooth of pars incisiva of masticatory joint is paired.

Fifth limb: Of about same type as in *C. (Cythereis) montereyensis,* ♀. Of the two bristles at the knee, the slender medial one is strikingly longer than the lateral (about one and one-half times longer or even somewhat more). Proximo-dorsal spine on end claw developed just as in *C. (Procythereis) radiata;* no proximo-ventral spine was detected. Pectination of end claw of moderate strength.

Sixth limb: Differs from that of the female of *C. (Cythereis) montereyensis* mainly in the following respects: Bristle on posterior side of protopodite furnished with a number of long hairs near base; distally to these hairs are numerous short hairs; end claw of same type as in fifth limb.

Seventh limb: Differs from that of female of *C. (Cythereis) montereyensis* mainly in the following respects: Bristle on posterior side of protopodite joint only about half to one-third as long; middle one of the three bristles on anterior side of this joint slightly shorter, being about as long as anterior side of joint; end claw of about same type and relative length as in sixth limb.

Genital verruca seems to be of about same type as in *C. (Procythereis) iganderssoni.*

Description: Male; unknown—

Remarks: The systematic position of this species is somewhat uncertain. In some respects it approaches *C. (P.) radiata,* in others *C. (P.) torquata* and *iganderssoni.* Its assignment to the Torquata group is due mainly to the type of the genital verruca of the female. Its allocation can not be decided with certainty until the male has been examined.

Habitat: **South Georgia**—S.A.E., station 28, lat. 54° 22′ S., long. 36° 28′ W. (type-locality); 24.V. 1902; depth, 12-15 m.; sand and algae: One mature female and one larva.

Radiata Group nov.

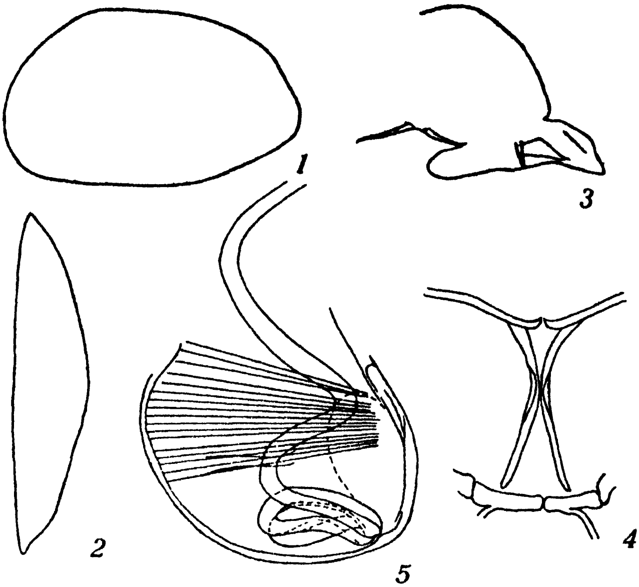
Among the species described in the present paper, *Cythereis (Procythereis) radiata* and *polita* belong to this group. Among those described previously, *Cythereis kerguelensis*, G. W. Müller, 1908, p. 138, in all probability also belongs here. G. W. Müller, 1908, suggested that this species would be closely related to *C. convexa* G. W. Müller, 1894. This view presumably is incorrect; *C. convexa* appears to be a typical member of the subgenus *Cythereis.* The question as to whether *C. kerguelensis*, G. W. Müller, 1908, is identical with *C. kerguelenensis* G. S. Brady, 1880, can not be decided as yet. The description and figures of this species given by Brady are too incomplete and uncertain to allow a well founded identification of species. (It is to be noted G. W. Müller, 1908, 1912, used the name *kerguelensis* instead of *kerguelenensis.)*

C. (Procythereis) radiata, new species

Plate I, fig. 4; Plate IV, fig. 3; text fig. IV.

Description: Male—

Shell: Length, 0.80 mm.; length: height, about 1.75:1; length: breadth, about 2.3:1. Seen from the side: Left valve (text fig. IV, 1): Of about same shape as in *C. (Cythereis) montereyensis;* dorsal margin, however, slightly more flattened anteriorly, and ventral margin somewhat more arched just behind middle and not sinuated in front of middle; margin without teeth and crenulation. Right valve: Somewhat longer than left one and at the same time somewhat lower relatively. It differs from that of *C. (Cythereis) montereyensis,* ♂, mainly in the following respects: Somewhat lower relatively, especially posteriorly; dorsal margin slopes slightly more posteriorly and sinuation of ventral margin seems to be broader. Seen from above (text fig. IV, 2), of about same shape as in *C. (Cythereis) montereyensis,* ♂, with greatest width at about middle. Sculpture of surface of shell: Ventral main ridge one-sided and rather low, well developed along entire ventral margin of shell; posteriorly it is continued by a low ridge, running at some distance from, and about parallel to, posterior margin of shell. Surface of shell covered with



Text fig. IV. *Cythereis* (*Procythereis*) *radiata*, n. sp. 1, 2, 3, 4, ♂, type specimen. 5, ♀.

1. Left valve from the side. ×49.
2. Left valve from below. ×57.
3. Right penis. ×115.
4. Chitinous support of posterior part of body dorsally to the penes; the parts below the X belong to penes. ×175.
5. Genital verruca from lateral side. ×800. Tierra del Fuego, Borja Bay.

numerous rather closely-set excavations of different sizes; excavations on posterior half of shell usually of moderate size, those on anterior half generally somewhat smaller; most of these excavations more or less rounded, some sub-angular; most of them arranged in rather distinct rows, radiating from center of shell (a character from which the species has been named); in center of shell excavations are rather few and scattered. Along anterior margin and along anterior part of ventral margin, shell has about twenty-five to thirty flattened, leaf-like, hyaline bristles of moderate length furnished with short, fine marginal hairs; among these bristles a number of narrow, simple bristles of moderate length occur, and along ventral and posterior margins of shell, there are a few narrow, simple bristles of moderate length. When shell is regarded by transmitted light, no dark fields are to be detected (of course, the ridges excepted).

First antenna: Of about same shape as in text fig. VI, 5, of *C. (Cythereis) montereyensis;* fourth joint, however, slightly longer relatively, being about $\frac{7}{6}$, according to scale used in the subgenus *Cythereis.* Latero-distal claw of fourth joint about as long as end joint and of about same size and type as in *C. (Procythereis) torquata,* or somewhat stronger. Other claws and bristles of about same types and relative lengths as in text fig. VI, 5 of *C. (Cythereis) montereyensis,* with the following exceptions: Long distal claw of fourth joint usually somewhat more curved than in this figure, somewhat shorter than posterior side of second joint, and somewhat more than twice as long as end joint; the narrow bristle in front of proximal claw of fourth joint somewhat shorter than claw, its length, however, as in most other species of this genus, probably rather variable. Pilosity: There seems to be no longitudinal row of hairs on lateral side of first joint; on medial side of this joint there is an irregular, longitudinal row of short hairs; these hairs were almost scattered in the male and female examined by me; hairs along anterior side of second joint very short; only a bunch of rather long hairs are to be found near proximal boundary of this joint; hairs on the two distal joints very short and weak.

Second antenna: Protopodite, endopodite, and exopodite have about same shapes as in text fig. VI, 6 of *C. (Cythereis) montereyensis,* but second endopodite joint slightly longer relatively. Among bristles of second endopodite joint, the two on anterior side and the group of three at about middle of posterior side are situated a little more distally than in the mentioned figure. Of the three last-mentioned bristles, the two lateral ones are of about same types as in *C. (Cythereis) montereyensis;* the medial one of them only about half as long as the postero-lateral, of about same shape as in text fig. XVI, 3 of *C. (Cythereis) ephippiata,* and furnished with fine pectination. The powerful postero-distal bristle of this joint slightly shorter relatively than in text fig. VI, 6 of *C. (Cythereis) montereyensis* and not so weak distally. Pilosity: On lateral side of protopodite there is a number of more or less scattered, very short hairs; hairs on anterior side of second endopodite joint somewhat more numerous and longer than in the mentioned figure of *C. (C.) montereyensis.* Of the distal plates of second endopodite joint, the lateral one is furnished with rather strong spines, the medial with very fine pectination. Proximal end claws have fairly strong pectination.

Mandible: Masticatory joint: Anterior tooth single, just as in all the species of the subgenus *Cythereis;* spine next to posterior bristle on pars incisiva exceedingly small (sometimes not developed at all ?). Hairs in the row of hairs on medial side of second endopodite joint of moderate length.

Fifth limb: Of about same type as in *C. (Cythereis) montereyensis.* Differences (see also description of subgenus): Bristle on posterior side of protopodite somewhat stronger; bristle on first exopodite joint with a blunt point in the specimen examined; end claw with weak pectination and with a small spine ventrally near base; length of this spine about one-third the height of claw at point of attachment of spine; somewhat proximally to this spine, there is on dorsal side of end claw a still smaller, vestigial spine. The position of these two spines indicates that they are to be considered as vestiges of two bristles on the original end joint, which is now merged with the end claw.

Sixth limb: Of about same type as in *C. (Cythereis) montereyensis,* ♂. Differences: Middle bristle on anterior side of protopodite joint about as long as this side; bristle on posterior side of this joint of about same type and size as corresponding bristle of fifth limb; end claw resembles that of fifth limb.

Seventh limb: This appendage differs from that of *C. (Cythereis) montereyensis,* ♂, mainly in the following respects: Middle one of the three bristles on anterior side of protopodite joint perhaps slightly shorter relatively; bristle on posterior side of this joint only about half as long as in text fig. VIII, 16 of *C. (Cythereis) montereyensis,* or somewhat shorter. Bristle of first exopodite joint has same narrow shape and about same relative length as corresponding bristle of sixth limb; i.e., it is almost as long as second exopodite joint; it is, however, furnished with numerous short hairs, while this bristle of sixth limb has but a few short hairs or is almost naked. End claw, which has two proximal spines, just as end claws of the two preceding limbs, is, perhaps, slightly shorter than in text fig. VIII, 16 of *C. (Cythereis) montereyensis.* End claws of fifth and sixth limbs are, perhaps, also slightly shorter relatively than in the mentioned species.

Brush-shaped organ of about same type as in *C. (Cythereis) montereyensis.*

Penis: About as shown in text fig. IV, 3 and in plate IV, fig. 3. Vas deferens has spiral thickenings; ductus ejaculatorius of moderate length, moderately curved, concave ventrally, and ends in a free point at about middle of ventral edge of copulatory appendage. Body of penis rounded and characterized by a lateral three-branched chitinous strip, which ends at postero-dorsal corner of copulatory appendage. Copulatory appendage characterized by a rather large postero-ventral process, which is fairly broadly rounded distally; edge of this process furnished with radiating, partly branched striae. Anterior part of copulatory appendage of moderate length and height, pointed, resembling bill of a crow; this appendage of left penis differs slightly from that of right penis in having dorsal edge more uniformly convex.

Description: Female—

Shell (Pl. I, fig. 4): Length, about 0.84 mm.; length: height, about 1.7:1. Of about same shape and structure as in male but somewhat higher relatively.

Second antenna: Of about same type as in male.

Fifth limb: Of about same type as in male; bristle on posterior side of protopodite somewhat swollen at base and furnished with long, soft hairs; bristle of first exopodite joint well pointed.

Sixth limb: Resembles that of male; bristle on posterior side of protopodite similar to corresponding bristle of female fifth limb; bristle of first exopodite joint of same type and size as corresponding bristle in *C. (Cythereis) montereyensis,* ♀.

Seventh limb: Resembles that of male, but bristle of first exopodite joint, perhaps, slightly stronger and shorter.

Genital verruca (text fig. IV, 5): Of about same type as in *C. (Cythereis) montereyensis,* but ductus is somewhat S-shaped and forms distally a little bundle of about two and one-half coils.

Remark: One mature male, one mature female, and one larva were examined.

Habitat: **Falkland Islands**—S.A.E. station 51, **Port William**; 3.1X,1902; depth, 22 m.; sand: One empty shell.

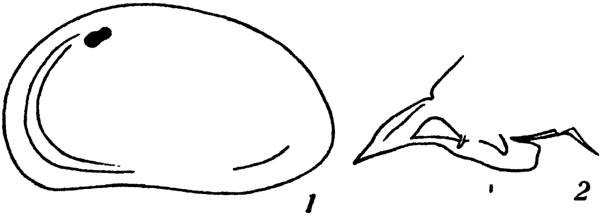
Tierra del Fuego: Borja Bay; 7.IV.1896; depth, 18 m. (type-locality): One mature male, one mature female, and one larva (Swedish Magellan Exp. 1896).

C. (Procythereis) polita, new species

Plate I, fig. 5; Plate IV, fig. 4; text fig. V.

Description: Male—

Shell (Pl. I, fig. 5): Length, about 0.67 mm.; length: height, about 1.8:1; length: breadth, about 2.1:1. Seen from the side: Left valve: Subreniform, with greatest height situated somewhat in front of middle; anterior margin without, or at any rate with hardly distinguishable, crenulation; dorsal margin, which is evenly and rather strongly arched, slopes fairly steeply backwards and does not form distinct corners with anterior and posterior margins; posterior extremity rather narrow, well and evenly rounded, without teeth; ventral margin somewhat sinuated just in front of middle of shell. Right valve: Differs from the left mainly in the following respects: Anterior margin slightly sinuated dorsally; dorsal part of posterior margin slightly sinuated. Seen from above, shell has about same shape as in *Cythereis kerguelensis,* G. W. Müller, 1908, p. 139. Sculpture of surface: Ventral main ridge very low, scarcely distinguishable; no other ridges developed. Surface has rather numerous, small, rounded pits, most of which are situated on posterior half of shell; on anterior half but few scattered pits are to be found; some of the pits, especially near margin of shell, arranged in rows, which run more or less parallel to margin of shell; number of pits somewhat variable. Along anterior margin and along anterior part of ventral margin of shell, there are about 20 to 25 hyaline, leaf-like bristles with marginal hairs (of about same types as in *Cythereis kerguelensis,* G. W. Müller, 1908, fig. 5); among these bristles and along ventral and pos-



Text. fig. V. *Cythereis* (*Procythereis*) *polita*, n. sp.
1. Left valve from the side, ♀. Tierra del Fuego, Isthmus Bay. ×60.
2. Left penis, type specimen. Tierra del Fuego, no definite locality. ×135.

terior margins of shell, there are a few narrow, simple bristles of moderate length. When regarded by transmitted light, no dark fields are to be detected.

First antenna: Of about same type as in *C. (Procythereis) radiata.* On lateral side of first joint there is proximally a short longitudinal row of hairs; latero-distal claw of fourth joint slightly shorter than end joint.

Second antenna: Of about same type as in *C. (Procythereis) radiata.* Bristle of first endopodite joint somewhat shorter than in *C. (Cythereis) montereyensis;* spines on disto-lateral plate of second endopodite joint rather weak.

Mandible: Of about same type as in *C. (Procythereis) radiata,* but anterior tooth of pars incisiva of masticatory joint is paired.

Fifth limb: Of about same type as in *C. (Procythereis) radiata,* ♂. Of the two bristles at the knee, the weak, medial one is rather strikingly longer than the strong lateral one. (In *C. [Procythereis] radiata* these bristles have about same relative lengths as in text fig. VIII, 14 of *C. Cythereis montereyensis.)* Bristle of first exopodite joint of subuniform thickness throughout its entire length but has a sharp point.

Sixth limb: Of about same type as in *C. (Procythereis) radiata,* ♂. Bristle of first exopodite joint about as long as second exopodite joint.

Seventh limb: Of about same type as in male of *C. (Procythereis) radiata.* Bristle on posterior side of protopodite about one-third as long as corresponding bristle in *C. (Cy-*

thereis) montereyensis; bristle of first exopodite joint of about same type and length (i.e., about as long as second exopodite joint) as corresponding bristle on sixth limb but has numerous short hairs; end claw about as long as distal joint, just as in the two preceding limbs.

Brush-shaped organ: Of about same type as in *C. (Procythereis) radiata.*

Penis (Pl. IV, fig. 4; text fig. V, 2): Very similar to this organ in *C. (Procythereis) radiata.* Main difference is that postero-ventral, beak-like process of copulatory appendage is truncate posteriorly and has but a slight indication of marginal striation; dorso-posterior chitinous support of penis has about type shown in text fig. IV, 4 of *C. (Procythereis) radiata.*

Description: Female—

Shell (text fig. V, 1): Length, about 0.70-0.74 mm.; length: height, about 1.7-1.75:1; length: breadth, about 2:1. Seen from the side of about same shape as in male but somewhat higher relatively, and its dorsal margin slopes slightly less posteriorly. Seen from above it also resembles that of male, with the exception that it is slightly broader relatively. In other respects shells of the two sexes agree.

Second antenna: Of about same type as in male.

Fifth limb: Of about same type as in *C. (Procythereis) radiata,* ♀; bristles at knee about as in male.

Sixth limb: Of about same type as in female of *C. (Procythereis) radiata.*

Seventh limb: Of about same type as in female of *C. (Procythereis) radiata.* For length of bristle on posterior side of protopodite and of end claw, see description of male; bristle of first exopodite joint distinctly shorter than second exopodite joint.

Genital verruca about as in *C. (Procythereis) radiata.*

Remark: One male and two females were examined.

Habitat: **Tierra del Fuego**—No definite locality; 5.II; 1896; depth, 18 to 36 m.: One mature male (type specimen). **Isthmus Bay**; 29.III.1896; tide-pool: Three mature females, one larva (S.M.E.).

Subgenus **Cythereis** (T. R. Jones)

Description:

Shell: Without or with rather slight sex dimorphism. The shape of the shell and the sculpture of the surface show very striking differences in the different species; within each species, on the other hand, they are usually fairly constant. The anterior margin of the shell is apparently always of about the same shape as in *C. (C.) montereyensis;* i.e., it is boldly and evenly rounded, slightly flattened dorsally, and joins the ventral margin without forming any distinct corner. The left valve usually somewhat larger than the right; the difference in size is, however, varying even within the species. The inner line runs at a moderate distance from and about parallel to the margin of the shell. The line of concrescence either coincides entirely with the inner line, or these lines are separated only along a short distance inside the anterior margin of the shell. The marginal pores are very numerous; their number varies, however, even within the species. Especially along the anterior margin and along the anterior part of the ventral margin of the shell, they are very closely set. Along the posterior part of the ventral margin and along the posterior margin, they are more widely spaced. Most of these pores are somewhat widened at about their middle or near the margin of the shell; all or nearly all of them are simple. A great number of them are furnished with simple and generally flattened marginal bristles. (As an illustration of this description, I refer to Plate XXVIII, fig. 19, *Cythereis convexa,* G. W. Müller, 1894.) The pores of the surface of the shell seem usually to be moderate in number. Some of them have a short, simple bristle. (Frequently these pores are very difficult to detect.) The selvage is in most cases very difficult to distinguish. It seems to be rather narrow or of a moderate width, striated, and its edge is even or nearly so. The eye appears always to be present. The hinge of the right valve consists of one anterior and one posterior terminal tooth. On the left valve there is one anterior tooth, situated just behind the anterior tooth of the right valve. The three teeth are rather strong and fit into corresponding sockets of the opposite valve. Between the teeth there is in most cases a more or less developed ridge which fits into a corresponding furrow on the opposite valve. The muscle-spots usually very difficult to distinguish. In most cases they appear to be of about the type shown in text fig. VI, 4 of *C. (C.) montereyensis*. Sometimes, however, I was not able to detect the small dorsal and ventral spots. The two central groups, consisting of three and four spots respectively, seem always to be present. Often the field occupied by the muscle-spots is somewhat elevated. In all the species of this subgenus examined by me, the shell was characterized by a strong calcareous incrustation.

First antenna: This limb has no sex dimorphism. Normal type: Strong and of moderate length; five-jointed; most of the joints with rather thick walls. Relative lengths of the joints about as follows. [These figures are from measurements of *C. (Cythereis) glauca* n. sp.]

I. $\frac{11}{15}$ II. $\frac{13^{*}}{10}$ III. $\frac{4}{5}$ IV. $\frac{-}{-}$ V. $\frac{3}{4}$

The length of the fourth joint is variable. In the species mentioned above it is about $\frac{7.5}{6.5}$. Exceptionally it is as short as $\frac{7}{5}$ [*C. (Cythereis) montercyensis*], and as long as $\frac{11}{10}$ [*C. (Cythereis) frequens*]. Generally speaking, the joints are somewhat narrower the more distally they are situated. The distal joint is rather narrow and of subuniform width throughout its whole length. The fourth joint is always characterized by the fact that it suddenly grows narrower at about the middle, the anterior edge of this joint being strikingly notched at about the middle. The number of the bristles seems to be constant; anyhow, in the specimens examined by me, I found no variation in this repect. The positions of the bristles appear to be practically the same in all species. In regard to shape and strength, too, the bristles are remarkably constant. Only the claw-like bristles of the three distal joints show some variations in their shapes, being more or less curved. These differences seem not to be specific, since rather pronounced variations are found even within the species. The

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[*] The second joint seems to have a rather constant relative length within this subgenus. Thus, when giving the relative lengths of the joints of this antenna, I have always in this paper started from 13 as the length of the anterior side of the second joint. In other words, the figures in the descriptions of this paper give only the proportions between the length of the anterior side of the second joint and the lengths of the remaining joints. Nevertheless, these figures give a fair idea of the shape of the limb.

relative lengths of the bristles are rather constant, even though small variations seem to occur in most species; it does not appear advisable to attach much taxonomic value to differences in this respect. The first joint lacks bristles. The second joint has postero-distally a bristle of moderate strength, about as long as or somewhat longer or shorter than the posterior side of this joint, more or less distinctly annulated, and furnished with fine, short hairs. On the third, fourth, and fifth joints there are altogether four powerful, pointed claws which may be straight but generally are slightly curved. One of these is located antero-distally on the third joint; one at about the middle of the anterior side of the fourth joint; one antero-distally on the fourth joint; and one distally on the distal joint. Of these claws, all of which are finely pectinated, the proximal one is usually somewhat weaker than the others; and its tip reaches somewhat beyond the point of attachment of the next claw. The three remaining claws are subequal and about as long as or somewhat shorter (exceptionally somewhat longer) than the posterior side of the second joint. The third joint has no bristles except the antero-distal claw-like one mentioned above. Fourth joint: Near the proximal claw there are two long, narrow, naked, non-annulated bristles. One of these, situated in front of the claw, is somewhat longer to somewhat shorter than this claw (usually somewhat shorter). The other, situated behind the claw on the inner side of the joint, is longer; its point reaches to or nearly to the point of the distal claw of this joint. Close by the distal claw of this joint two similar bristles are to be found. These have the same positions and about the same relative lengths (or somewhat longer), when compared with the distal claw, as the two proximal bristles have, when compared with the proximal claw. Close by the distal claw of this joint, on the outer side of the joint, a short, powerful, spine-like bristle is to be found. This has a length about equal to the proximal thickness of the distal joint, and it is directed more or less forward (contrary to all other bristles of this limb which have about the same direction as the distal joint). This spine-like bristle, which I term the latero-distal spine, is usually furnished with some short hairs. Close by the end claw, the distal joint has two bristles of the same type and of about the same positions and relative lengths as the two long and narrow bristles close by the long distal claw of the fourth joint. The posterior of these two bristles is united at the base with a narrow, naked, non-annulated, sensorial bristle, which is somewhat rounded distally and usually not quite so long as the end claw. Pilosity: The pilosity of the first joint seems to be subject to rather pronounced variations. Within each species, on the other hand, it is fairly constant, even though some variations are found. A bunch of more or less long hairs seems to occur in almost all species proximo-ventrally-laterally; and dorso-distally nearly always a few short hairs are to be found. The pilosity of the four distal joints seems always to be fairly constant; slight variations occur, however, even within the species. Second joint: Along the proximal half of the anterior edge, often somewhat laterally, there is a more or less dense row of rather long hairs. Along the distal half of this edge, also somewhat laterally, a fine, dense pectination is to be found. Antero-distally the hairs of this pectination generally are somewhat longer. At about the middle of the posterior side there is a bunch of rather long hairs. The anterior edge of the third joint is naked or furnished with only a few hairs. Along the medio-distal edge of this joint, there is a dense, fine pectination of short hairs. The fourth and fifth joints are almost naked on the medial side. Only at the bases of the claws of these joints a few short, fine hairs usually occur. Along the lateral side we find a row, often discontinuous, of short hairs running slantingly from the antero-proximal corner of the fourth joint to the postero-distal corner of the fifth joint. Along the proximal part of the anterior edge of the fourth joint such hairs are also to be found. As an illustration of this description, I refer to text fig. VI, 5 of *Cythereis (Cythereis) montereyensis.*

Second antenna: This limb shows sex dimorphism. Normal type:

Male: Strong and of moderate size; four-jointed. Situated on a well developed, joint-like process, which is furnished with a strong chitinous support. In most species this support shows about the same shape [see text fig. XIX, 3 of *C. (C.) glauca*]; variations occur, however, even within the species. (As to the morphological interpretation of this joint-like process, see my paper of 1920, p. 79.) The three joints of the endopodite have rather thick walls. Relative lengths of these joints about as follows [from measurements of *C. (C.) glauca*]:

Protopodite $\frac{10}{8}$ Endopodite I. $\frac{7}{3\text{–}4}$ II. $\frac{17\text{–}18}{15\text{–}16}$ III. 2.

As a rule, this appendage is slightly more elongated and weaker than in *C. (C.) montereyensis;* see text fig. VI, 6 of this species. Generally speaking, the joints of the endopodite are narrower the more distally they are situated [exception, *C. (C.) platycopa*]; the distal joint is narrow and small. The second endopodite joint is characterized by the fact that it suddenly grows narrower at about the middle; its posterior edge being rather strikingly notched at this place. The protopodite has no bristles. The exopodite, which is of subuniform thickness throughout its entire length and about as long as, or generally somewhat longer than, the endopodite (without the end claws), usually is slightly weaker than in text fig. VI, 6 of *C. (C.) montereyensis.* It is generally two jointed. The proximal joint, which in most cases is somewhat more than twice as long as the end joint, shows, however, nearly always signs of an articulation somewhat distally to the middle; exceptionally this articulation is almost as distinct as the distal one. Endopodite: The first joint has one posterior bristle, which in most cases is somewhat shorter than the posterior side of the second endopodite joint, of moderate strength, non-annulated, and furnished with short hairs. [When not otherwise mentioned, it is about as long as in *C. (C.) montereyensis.*] Second joint: On the anterior edge, always somewhat distally to the middle of the joint, there are two closely-set, narrow, non-annulated bristles. Both of these usually are naked; however, a few short and fine hairs may be found on one or both of them; this character varies within the species. One of these bristles extends to the middle or even as far as to the point of the end claw. The other extends to about the middle or to the end of the distal joint. At about the middle of the posterior side, thus slightly proximally to the two bristles on the anterior side, there is a group of three non-annulated bristles. The postero-lateral one of these bristles, which is nearly always the longest [see *C. (C.) longiductus,* ♂, and *C. (C.) frequens,* ♂], is rather long, extends to or somewhat beyond the distal boundary of the joint, is of ordinary type, of moderate strength, and furnished with a short, more or less strong pectination. The antero-lateral one of them is rather narrowly claviform, naked, hyaline, sensorial, and not quite half as long as the postero-lateral one. The remaining one of these three bristles shows rather great variations within this subgenus. Postero-distally this joint has two closely-set, non-annulated bristles. One of these, which is very weak and short, usually is less than half the length of the other. The other is rather strong, somewhat curved, generally rather finely pectinated, and about twice as long as the end joint or somewhat shorter. Distal joint: With three slightly curved, rather powerful, non-annulated claws; one situated antero-distally; the two others posteriorly, slightly proximally to the first. The antero-distal one is usually about two to three times longer than the anterior side of this joint or slightly shorter. The two others are in most cases subequal and slightly shorter. The antero-distal is naked or almost so: the two others are weakly pectinated. [When not otherwise mentioned, the lengths of these claws are about the same as in *C. (C.) montereyensis.*] The pilosity is subject to slight variations, even within the species; it shows, however, on the whole, a rather constant type. Protopodite: Proximo-ventrally, there is a group of hairs of moderate length; sometimes these hairs are rather few and short. On the medial side, at or somewhat distally to the middle and somewhat above half the height of the joint, there is sometimes a slanting row of rather short hairs. In the neighborhood of this row, scattered short hairs are often to be found. Dorso-distally a few short hairs usually occur. At the base of the exopodite some short hairs also are to be seen. Endopodite: First joint: Near the anterior edge, often somewhat proximally to the middle of the joint, there is a group of more or less long hairs. Disto-anteriorly-laterally, some hairs are often to be found. Along the disto-lateral edge, a very fine, hardly distinguishable (Reichert's oc.4, Leitz's immers. $^1/_{12}$) pectination has been detected in a few species. This character, however, is not taken into consideration in my descriptions of species, on account of the difficulty in making a quite certain statement. Second joint: At a point about one-third of the length of the anterior edge of this joint, there is a bunch of hairs of moderate length. At the bases of the bristles located at about the middle of the anterior and posterior edges of the joint, some rather short hairs occur. Just proximally to the group of three bristles on the posterior edge of the joint, some very short hairs are to be found. This joint is continued distally by two thin rounded plates, which partly cover the medial and lateral sides of the distal joint. Along the posterior parts of the free edges of these plates, there is a series of rather short, spine-like hairs; proximally to which often a few rather short, fine hairs are to be found. Distal joint: At the base of the antero-distal claw, a series of short, spine-like hairs. (These are often so small that they are nearly invisible with Reichert's oc.4, Leitz's immers. $^1/_{12}$.) As an illustration of this description, I refer to my text fig. VI, 6 of *C. (C.) montereyensis.*

Description: Female—

This differs from that of the male chiefly in the following respects: The exopodite [see text fig. VI, 7 of *C. (C.) montereyensis*], which is somewhat reduced, usually about as long as or but slightly shorter than the anterior side of the second endopodite joint, is two-jointed in most species. The first joint, which generally shows no signs of further articulation, is in most species somewhat widened distally. As to whether the chitinous folds, which often occur at the base of this branch, are signs of articulation, I have no definite opinion. The distal joint, which is somewhat less than half the length of the proximal joint, is considerably narrower than the proximal joint, somewhat curved and irregular, and more or less pointed. The first endopodite joint: The bristle is usually somewhat longer than in the male. The medial one of the three bristles at about the middle of the posterior edge of the second endopodite joint has about the same type as the long postero-lateral one of these bristles, but is somewhat shorter, usually not quite as long as in text fig. VII, 8 of *C. (C.) montereyensis.* The two proximal claws of the distal joint are often furnished with slightly stronger pectination than in the male.

Mandible: Without or with but slight sex dimorphism. Normal type: The masticatory joint, i.e., the first protopodite joint, has in nearly all the species of this subgenus examined by me almost perfectly the same type as in text fig. VII, 9 of

C. (C.) montereyensis. In other words, it is very strong, rather short, and wedge-shaped. Its lower half is very broad and almost square; its upper half tapers dorsally. At about the middle of the posterior side it is distinctly notched; and sometimes it has a rounded hump on the anterior side of its upper half. The toothed edge of the pars incisiva is broad and has a number of smooth, almost equilaterally triangular teeth; these, generally speaking, decrease slightly in size the more posteriorly they are situated. The two anterior ones and the posterior one of these teeth (the last is rather narrow) are usually single. Exceptionally the next to the anterior tooth is paired, and the posterior one may be slightly bifurcated distally. Between these single teeth five pairs of teeth are to be found, corresponding to five deeply bifurcated teeth. The next to the posterior pair, which sometimes is represented by a single tooth, is in some cases very small. Behind and close by the posterior, single, tooth, a short narrow bristle is to be found. Between teeth Nos. 1 and 2 (counted from in front), there are two short, slightly bent bristles; and between tooth No. 2 and the first pair of teeth (or, if tooth No. 2 is paired, between the first and second pairs of teeth), a similar, smaller, more or less bent bristle is to be found. The types of these bristles vary somewhat even within the species; usually they are about as in text fig. VII, 10-12 of *C. (C.) montereyensis.* On the anterior side of the masticatory joint, just below the palp, there is a short, usually slightly annulated, sometimes non-annulated, bristle with short hairs; this bristle is about as long as, or somewhat shorter than, the end joint of this limb. In all the species of this subgenus, which I have had the opportunity to examine, the palp shows almost perfectly the same type as in text fig. VII, 9 of *C. (C.) montereyensis.* It is rather large. Its length is subequal to the height of the masticatory joint. Its proximal height nearly equals the width of the toothed edge of the pars incisiva of the last-mentioned joint; and it grows gently narrower distally. The end joint is rather narrow, of subequal height throughout its entire length, and strikingly narrower than the distal part of the preceding joint. The number of joints is difficult to establish with full certainty. However, according to the muscular system, there are probably four joints. Only the distal joint is sharply marked off from its predecessor. The proximal boundary of the next to the distal joint is in most species rather distinct. The relative lengths of these joints are about as follows: [The figures taken from measurements of *C. (C.) montereyensis.*]

Protopodite II. $\frac{4}{4}$ Endopodite I. $\frac{7}{4}$ II. $\frac{6}{6}$ III. $\frac{4}{4}$
The number of bristles seems to be almost perfectly constant; at any rate, in all the specimens of all the species but one [*C. (C.) longiductus*] examined by me, I found no variation in this respect. Their positions and types, too, show very remarkable constancy. Their relative lengths are rather constant; slight variations in this respect, however, are found even within the species. The second protopodite joint has two bristles. One of these, which is situated at about the middle of the ventral side of the joint, is usually non-annulated or almost so, has short hairs, and its length is subequal to the height of the joint. The other, which is directed more or less distally, and situated medially and somewhat distally to the first-mentioned bristle, is usually annulated, furnished with long secondary bristles, and its point generally extends to about the boundary between the first and second endopodite joint. The epipodial appendage is situated dorso-laterally near the distal boundary of the second protopodite joint. It is short, verruciform, and furnished with a rather long bristle, the length of which is subequal to the height of the second protopodite joint, and which is non-annulated and furnished with long hairs. In front of this bristle there are a very short, vestigial bristle and a rather short, peg-like, generally naked appendage. (It is difficult to state with full certainty whether or not this peg is naked.) In all the species of this subgenus examined by me this appendage had the type described above; but since it is extremely difficult in most specimens to establish its structure, I can give no information about the constancy within each species. It seems fairly probable, however, that it is rather constant. Endopodite: First joint: This has in most species four ventero-distal bristles [see *C. (C.) longiductus,* ♂, ♀]. Two of these are powerful, long, usually somewhat longer than the dorsal side of proximal joints of the palp, non-annulated, and furnished along the greater parts of their lengths with rather long and stiff hairs arranged in two

more or less distinct rows. The remaining two, which are situated medially to the others, are rather weak and short. Usually they are somewhat shorter than the distal height of this joint, and the ventral one of them is generally somewhat longer than the dorsal. They are furnished with short, or more or less long, hairs; and not annulated, or only rather slightly so. Dorso-distally this joint has a single bristle, which has about the type of the two last-mentioned bristles; it has short hairs, and in most species it is about as long as half the length of the second joint or somewhat more. Second joint: This has, at or slightly distally to the middle, a very powerful and long ventero-lateral bristle, which is distinctly longer and more powerful than the two long and strong ventro-distal bristles of the preceding joint. This bristle is non-annulated and furnished with rather long and soft hairs, situated on the convex side of the bristle. These hairs are much more numerous and closely-set than those of the long ventro-distal bristles of the preceding joint. Close by, and medially to, this long bristle, there is a weak, naked bristle, usually about as long as, or rather slightly longer than, the proximal width of the former. Dorso-distally this joint has eight bristles, most of which frequently are attached to a small verruciform process; see Plate 35, fig. 20, G. W. Müller 1894. Five of these bristles are rather narrow, non-annulated, naked, or almost so, and usually about as long as, or somewhat shorter or longer than, the dorsal side of the first and second endopodite joint. One bristle, which is not attached to the verruciform process, is generally somewhat shorter, but slightly more powerful, than these five bristles, distinctly annulated, and furnished with short hairs. The two remaining bristles are of about the same type but weaker, and usually only about half as long or even less. End joint: This has four distal bristles. Two of these are rather powerful, usually about twice as long as the joint, non-annulated, and naked or almost so. The dorsal one is about as strong as, but generally somewhat shorter than, the first two, annulated, and furnished with short hairs. The remaining bristle, which is ventero-medial in position, is only about as long as or even somewhat shorter than this joint, weak, non-annulated, naked or almost so. Although subject to some variations even within the species, the pilosity shows, on the whole, a very constant type. Along the anterior side of the masticatory joint, just dorsally to the bristle, a number of rather short, fine or rather coarse hairs occur. Endopodite: Along the dorsal side of the first joint, there is a number of rather long, partly fairly coarse hairs. Along the proximal half of the ventral side of the second joint, there is a series of hairs of moderate length. Close by, and laterally to, the strong ventral bristle of this joint, there is a bunch of hairs, usually of moderate length, and often rather stiff. On the medial side of this joint, somewhat below half its height, a longitudinal row of hairs occurs; generally most of these hairs are so small and fine that they are hard to detect even with Reichert's oc.4, Leitz's immers. $^1/_{12}$. The end joint often has fine pectination at the bases of the bristles.

Maxilla: This limb shows no, or at any rate scarcely perceptible, sex dimorphism. Normal type: The epipodial appendage is large and of about the type shown in Plate XXXV, fig. 13, G. W. Müller, 1894. In all the species, and specimens, examined by me, it had sixteen bristles of about the same type, relative lengths, and positions as in the mentioned figure. At the base of the dorso-anterior bristle, there is a rather small, rounded, lobe-like projection with a dense covering of fine, rather long hairs. The three endites are well developed, rather strong, and usually slightly increasing in length the more distally they are situated. The proximal, or first one, is about as long as high or slightly longer; the distal, or third one, is about twice as long as high or somewhat longer. First endite: With seven distal bristles of moderate length. The dorsal of these, which is situated somewhat proximally to the others, is rather powerful and furnished with fairly numerous long hairs. The others are of moderate strength or rather weak; most of them are more or less curved, non-annulated or almost so, some naked, some furnished with short or long hairs, or deeply bifurcated distally. Second endite: With seven to eight (usually eight) bristles. The number varies within the species; sometimes different even on the right and left maxilla of the same specimen. All these bristles are situated distally, of moderate length and strength, slightly curved, non-annulated or almost so, naked or a few of them have a few short or rather long hairs. Third endite: With seven distal and subequal bristles of moderate strength and length, which usually are slightly longer than those of the second endite. The dorsal one of them has at about the middle a varying number of long hairs; the others are naked or almost so; or some of them have a few, more or less long hairs. All these bristles are non-annulated or almost so. The palp is two-jointed. The proximal joint is about twice as high as the endites, of subuniform height throughout its entire length and about twice as long as high. The distal joint is about as high as, or somewhat lower than the endites; often slightly higher distally than proximally; and about half as long as the proximal joint or somewhat shorter. The proximal joint of the palp has, dorso-distally, a group of four bristles of moderate strength. One of these bristles is usually about as long as this joint and annulated; in some cases it has short hairs or is almost naked, sometimes it has hairs of moderate length. The other bristles are about half as long, more or less distinctly annulated, and generally furnished with short hairs, almost naked. On the lateral side, this joint has two ventero-distal bristles, which sometimes are attached to a very small scale-like process (corresponding to the exopodite?). One of these bristles is of moderate strength, about twice as long as the end joint or slightly longer, non-annulated or almost so, and furnished with a few short or moderately long hairs. The other is very short and weak, often almost vestigial, and situated dorsally to the first. Distal joint: With three subequal distal bristles of moderate strength. These are usually about twice as long as the end joint, non-annulated, and generally furnished distally with a few hairs of moderate length. The bristles on this limb show a rather great constancy. Indeed, the number seems always to be as described above. In a few specimens a slightly smaller number was found; but in these cases probably one or more bristles had been torn off. It is true that the types and the lengths of the bristles show some variations, especially in the endites; but even in these respects the species examined by me were remarkably constant. In most species there is a longitudinal, more or less dense row of hairs on the lateral side of the first joint of the palp. In a few species some hairs may also be found on the first endite. As an illustration of this description, reference is made to text fig. VII, 13 of *C. (C.) montereyensis.*

Fifth limb: Without or with but slight sex dimorphism. Normal type: Of moderate strength and length, and with four joints. The relative lengths of the joints are somewhat variable. Sometimes the three exopodite joints are subequal; sometimes the first exopodite joint is more or less distinctly longer than either the second or the third. The protopodite seems always to be somewhat shorter than the exopodite. The number of bristles seems to be perfectly constant; anyhow, in the specimens examined by me no variation was found in this respect. The positions of the bristles seem to be practically constant. The types and relative lengths of the bristles, on the other hand, are somewhat variable; even within the species, some variations have been recorded in this respect. The relative lengths of the bristles is the most variable feature of this appendage. Protopodite: At, or somewhat proximally to, the middle of the anterior side, there are two closely-set bristles of moderate strength, furnished with short hairs. One of these is distinctly annulated and in most cases about as long as the anterior side of the joint; the other is usually about half as long, or somewhat more, and fairly weakly annulated or non-annulated. Antero-distally, i.e., at the knee, there are two annulated bristles, with short hairs, and of moderate strength. The lateral one of these is usually somewhat stronger than the medial one. These bristles which are about as long as, or slightly longer or shorter than, the distal joint, may be subequal, or either of them may be somewhat shorter than the other; this last character is not fully constant even within the species. On the posterior side of this joint, near the proximal boundary, there is a single bristle of moderate strength and length. This bristle often shows sex dimorphism; it is usually short-haired in the male and furnished with long, soft hairs in the female. Exopodite: First joint: With a single ventero-distal bristle of somewhat varying type and length. Usually this bristle is non-annulated, with short hairs, of moderate strength, and about half as long as the second joint or somewhat shorter. The second joint has no bristle. Third joint: This has one bristle, the end claw. This is in most species gently curved, finely pectinated, often almost naked, rather strong, and about one and one-half times as long as the end joint. In the species examined by me I could find no, or at any rate no certain, vestiges of the two other end claws found in the more primitive forms. Although of a rather constant type, the pilosity is subject to variation within most species. Along the proximal half of the posterior side of the protopodite, there seems always to be a number of rather long hairs. Proximo-posteriorly, on the outside of this joint, numerous very short and fine hairs usually occur, which often are very difficult to detect even with Reichert's oc.4, Leitz's immers. $^1/_{12}$. Some short, stiff hairs are to be found at the bases of the bristles at about the middle of the anterior side of this joint. Distally on this, as well as on the remaining joints, there is usually a fine pectination, in most cases somewhat stronger the more distally the joint is situated, and chiefly developed on the lateral side of the limb. Along the ventral side of the exopodite some short hairs are developed in many species. This last character seems, however, frequently to be variable even within the species. Distally the protopodite has a complicated chitinous support of about the type shown in text fig. VIII, 14 of *C. (C.) montereyensis*. As an illustration of this description, I refer to text fig. VIII, 14 of *C. (C.) montereyensis*.

I have tried, as far as possible, to give accurate and detailed descriptions of all the appendages of the species treated in this paper. There are, however, differences among the species which, for practical reasons, are nearly impossible to describe or to reproduce. Examples of such differences are the thickness of the walls of the joints, and details in the complicated chitinous support at the knees of the last three appendages. It has seemed most convenient to avoid mentioning these details.

Sixth limb: Without or with usually rather slight sex dimorphism. Normal type: Of about the same type as the fifth limb, but slightly larger and generally somewhat more elongated. The relative lengths of the four joints show about the same variability as in the fifth limb. As to the constancy and variability of the bristles, I also refer to the description of the fifth limb. On the anterior side of the protopodite, three bristles are to be found; one somewhat proximally to the middle; one at about, or somewhat distally to, the middle; and one at the knee. These three bristles are of moderate strength, furnished with short hairs, and annulated; the annulation of the proximal bristle is, however, often rather weak. The lengths of these bristles are somewhat variable; the middle one usually about as long as the anterior side of this joint or somewhat longer; the remaining two generally about half as long or somewhat more. On the posterior side of the protopodite, we find a bristle at about the same place as in the fifth limb. Its type is somewhat variable. In many cases it is different in males and females, being short-haired in the males and furnished with long, soft hairs in the females. The exopodite has the same bristles as in the fifth limb. The bristle of the first exopodite joint is somewhat variable. In the females of some species it has about the same type and size as the corresponding bristle of the fifth limb. In most cases it is, however, slightly longer. In the males it is in most species distinctly weaker than in the female and about as long as or slightly longer or shorter than the second joint. The end claw has about the same type and relative length as in the fifth limb. The pilosity is of about the same type as in the fifth limb; about its variability, see the fifth limb. In most cases there are, however, no long hairs on the posterior side of the protopodite. The pectinations along the distal ends of the joints and also, perhaps, the pilosity on the ventral side of the exopodite seem usually to be somewhat more strongly developed than in the fifth limb. In the distal part of the protopodite there is a complicated chitinous support of about the same type as in the fifth limb. As an illustration of this description, reference is made to text fig. VIII, 15 of *C. (C.) montereyensis.*

Seventh limb: Without or with but slight sex dimorphism. Normal type: Of about the same type as the sixth limb, but somewhat larger and more elongated. As to the variability of the relative lengths of the joints and of the bristles, see the fifth limb. With the same number of bristles and with about the same positions of the bristles as in the sixth limb. The proximal bristle on the anterior side of the protopodite seems always to be small, sometimes even vestigial. The two remaining bristles on this side are well developed, of moderate strength, annulated, and furnished with short hairs. Their lengths are somewhat different in the various species; and even within many of the species, slight variations are to be found. The bristle on the posterior side of the protopodite has about the same type as the two last-mentioned bristles. Its length is somewhat variable: it is, however, always well developed. The ventero-distal bristle of the first exopodite joint is of somewhat varying types. Usually it has about the same type as the corresponding bristle of the female sixth limb; but in most cases it is slightly longer, being somewhat longer than half the second exopodite joint, but not quite as long as this joint. The pectination of the end claw is usually somewhat better developed than in the sixth limb. The relative length of this claw is generally about the same as in the sixth limb; i.e., about one and one-half times the length of the distal joint. The pilosity is also about the same as in the sixth limb, but the pectination along the distal ends of the joints and the pilosity along the ventral side of the exopodite seem frequently to be somewhat better developed. In the distal part of the protopodite, there is a complicated chitinous support of about the type shown in text fig. VIII, 16 of *C. (C.) montereyensis*. As an illustration of this description, reference is made to the mentioned figure of *C. (C.) montereyensis*.

The chitinous support of the last three limbs, on the sides of the posterior part of the body, has usually about the type reproduced in text fig. IX, 17 of *C. (C.) montereyensis*. I have not found any distinct sex dimorphism in this structure. The support shows rather important variations even within the species. Some of the stripes represented in the mentioned figure may be absent, or some additional ones may be found. Also, the shapes of the different stripes frequently are somewhat different in the various specimens. I have not considered it worth while to note and reproduce these variations. They appear to be of little or no systematic value.

Brush-shaped organ: This organ seems to be subject to but slight variation within the subgenus. It is of moderate length and width, usually subequal in width throughout its entire length, rarely somewhat wider distally than proximally, straight or almost so, and furnished distally with a great number of subequal, soft bristles. The number of these bristles appears to be somewhat different in the various species. The number is, however, almost impossible to state with certainty, even when the appendage is observed crushed under the cover glass. Thus no definite statements of this character are given in my descriptions; and my figures of this organ should in this respect be considered as generalized.

Penis: This organ shows so great differences in the species examined by me, that it seems best to postpone a subgeneric description. Within each species, on the other hand, it appears to be characterized by a very great constancy.

Genital verruca of the female: This has the same type on the right and the left sides of the body and is subject to very slight variation within the subgenus. Normal type: Rounded to slightly oval. The shape is somewhat altered by the pressure of the cover glass; and when the organ is examined without any cover glass being used, it often is seen in a more or less slanting position. With a bundle of four to several (different in the various specimens of the same species) narrow muscles attached close by (and to?) the distal part of the duct and along the posterior side of the verruca. The duct opens on the anterior-medial side of the verruca. It runs almost straight up into the body and does not form any coil within the verruca. As an illustration of this description, I refer to text fig. IX, 19 of *C. (C.) montereyensis.*

Furca:

Female: Subject to but slight variation within the subgenus. It consists of two rather small verrucæ, located just inside, or just behind, the two genital verrucæ. Distally each furcal verruca has two plumose bristles. The posterior one of these is moderate in length; the anterior frequently is about half as long or somewhat more. On the posterior medial sides, the furcal verrucæ are frequently furnished with fine and rather long hairs. As an illustration of this description, reference is made to text fig. IX, 19 of *C. (C.) montereyensis.*

Male: In this sex the furca consists, on each side of the body, of two bristles which have about the same type as in the female; i.e., just as in the female the posterior of these two bristles is usually somewhat longer than the anterior. In addition to these two bristles, there is, in nearly all species (only the exceptions are mentioned in the following descriptions of species), a short, almost vestigial, narrow, naked, medial bristle. The furcal verrucæ are very small in most species, hardly distinguishable.

The posterior part of the female body is short and more or less rounded. The posterior extremity has a short bristle usually situated on a process, which appears verruciform when the body is examined from the side [text fig. IX, 19 of *C. (C.) montereyensis*]. The back of the posterior part of the body is sometimes furnished with short spines, either arranged in more or less irregular transverse rows [text fig. IX, 19 of *C. (C.) montereyensis*], or irregularly distributed.

Lips: Without sex dimorphism—Of nearly the same types in all the species of this subgenus described in this paper. The upper lip is helmet-shaped, with a rather strongly rounded anterior margin, when examined from the side. It is bordered proximally by a transverse chitinous strip. The lateral parts of this strip, which usually are somewhat stronger than the middle part, are united to the latter by flexible joints. From each of these two joints a rather strong chitinous strip descends to the antero-ventral edge of the lip. Each of these two strips is evenly and well curved, concave ventrally; and its ventral half is somewhat strengthened and furnished with a rather dense series of stiff and fairly long hairs. Somewhat dorsally to these two strips, and about parallel to them, another pair of chitinous strips is to be found. This pair also issues from the above-mentioned transverse strip and runs at a rather great distance from the median line of the lip towards the antero-ventral edge of the lip, which it, however, never seems to reach. This pair is rather weak and may even be absent. In most species an irregular chitinous bar occurs along the dorsal edge of the mouth. Above the upper lip there is an A-shaped chitinous support, attached to the transverse strip by flexible joints at the points where the lateral and medial parts of the transverse strip meet. Rarely the cross-bar of the A is absent. Between the dorsal pair of longitudinal chitinous strips of this lip, there are two transverse groups of fine hairs, the ventral group often discontinuous in the middle. As an illustration of this description, see Plate III, figs. 4 and 5. The lower lip is characterized by a rather large, boat-like, unpaired appendage, on the ventral side of which a varying number of soft, rather long hairs are to be found. On either side, and in front, of this, some rather small and somewhat irregular lobes are developed, more or less richly furnished with fine hairs. As an illustration of this description, reference is made to text fig. XIX, 6 of *C. (C.) glauca.*

The chitin of the body is, generally speaking, characterized by a more or less distinct yellowish color.

The type species of this subgenus, and thus also of the genus as a whole, is one of the species of *Cythereis* described by Jones (1849).

Arrangement of the species: The species of this subgenus treated in this paper have been divided into six groups, viz., the *Montereyensis, Taeniata, Discophora, Frequens, Ephippiata,* and *Glauca* groups. All these groups are characterized especially by the shape and structure of the penes.

Montereyensis Group nov.

Two of the species described in this paper belong to this group, viz., *C. (C.) montereyensis* and *pacifica.*

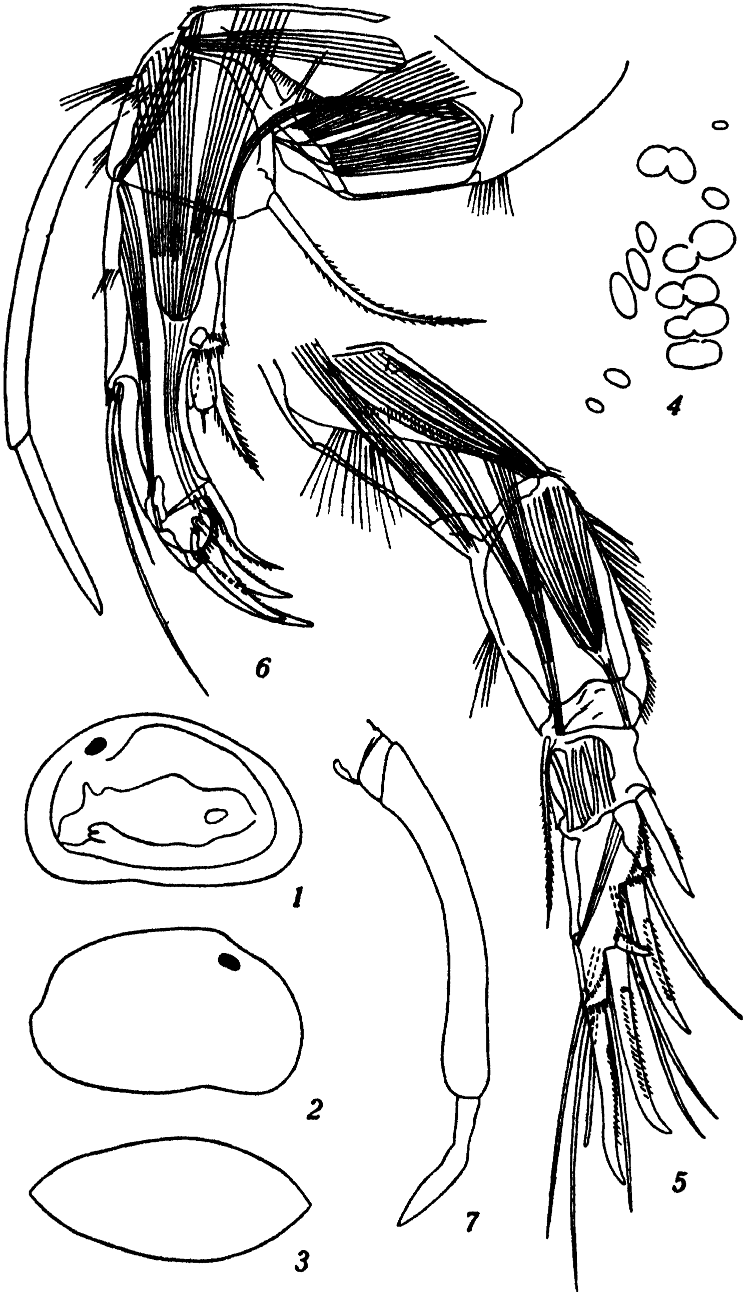
C. (Cythereis) montereyensis, new species

Plate III, figs. 4, 5, 8; Plate VI, figs. 1 and 2; text figs. VI to IX.

Description: Male—

Shell: Length, 0.63-0.65 mm.; length: height, about 1.70-1.80:1; length: breadth, about 2.1-2.3:1. Seen from the side and from below, of the same shape as in *Cythereis kerguelenensis* (G. S. Brady). (Compare G. S. Brady's "Challenger" Report, 1880, Plate XX, fig. 1a-1f and my text fig. VI, 1-3 of this species; male and female are similar.) Left valve somewhat larger than right; difference in size varies, sometimes very slight, sometimes rather conspicuous. As to the differences between shapes of the two valves, compare my figures; shape not perfectly constant, variations, however, rather slight. Margin of shell usually nearly smooth, sometimes, however, a few more or less distinct teeth along the postero-ventral part of shell. Sculpture of surface of shell somewhat variable; in specimens examined it is about as follows: Entire surface has numerous, usually more or less rounded depressions of somewhat different sizes, some depressions being more or less small, others of moderate size (Pl. III, fig. 8). Arrangement of depressions rather irregular; some depressions, especially near margin of shell, arranged in more or less distinct rows of different lengths which either run in various directions or, and this seems to be the rule, more or less parallel to margin of shell; in middle of shell most of the depressions are scattered quite irregularly. Near margin of shell cavities are usually very closely set, especially on posterior part of shell (Pl. III, fig. 8); near middle of shell, on the other hand, they are in most cases distinctly more widely spaced. Somewhat inside ventral margin of shell, there is a low, in some specimens hardly distinguishable ridge, often characterized by a single, rather distinct row of rounded to elongated depressions of different sizes. (As to the position of this ridge, see G. S. Brady's [1880] figures of *C. kerguelenensis*, mentioned above.) Along ventral margin of shell, there is also a low, smooth ridge, which partly covers edge of shell when this is observed from the side. With regard to variations of sculpture, see description of female shell. Pores of surface moderate in number but rather conspicuous; some have rather short bristles. Along anterior margin and along anterior part of ventral margin of shell, there are about 50 to 60 lanceolate, hyaline bristles, furnished with marginal hairs; along posterior part of ventral margin and along ventral part of posterior margin, there are about 20 to 32 similar bristles; some ordinary bristles also occur among these bristles (Pl. III, fig. 8). When seen by transmitted light, the part of shell which lies inside line of concrescence is reddish; outside this line, shell is almost uncolored. It is to be noted that the central part of shell, indicated in text fig. VI, 1 by an irregular line, is rather strongly incrustated with lime; by transmitted light this area is rather dark, by reflected light milkish white. This area somewhat variable in shape; usually, Text fig. VI. *Cythereis* (*Cythereis*) *montereyensis*, n. sp.; not type.

1. Left valve from the side, ♀. ×56.
2. Right valve from the side, ♀. ×56.
3. Shell from above; anterior end to the left, ♂. ×58.
4. Muscle spots of right valve from the medial side; the two small spots located low and to the left are antero-ventral in position, ♂. ×175.
5. Right first antenna from the lateral side, ♂. ×425.
6. Left second antenna from the medial side, ♂. ×425.
7. Exopodite of second antenna, ♀. ×425. California, Carmel Bay.



however, about as shown in text fig. VI, 1; in its posterior part, it has generally a small window, if I may say so, in which incrustation is less developed.

First antenna (text fig. VI, 5): Slightly stronger and shorter than usual. Relative lengths of joints about as follows:

I. $\frac{10}{14}$ II $\frac{13}{10}$ III. $\frac{3}{4}$ IV. $\frac{7}{5}$ V. $\frac{2.5}{3}$

Somewhat dorsally to half the height of first joint, there is, laterally, a longitudinal row of short hairs. On inner side of this joint there is a rather dense row of hairs of different lengths, most of them of moderate length, running in a curve from a point somewhat dorso-distally to proximo-ventral corner of joint to, or nearly to, dorso-distal corner of joint; length of this row variable.

Second antenna (text fig. VI, 6): Slightly stronger and shorter than usual. Exopodite slightly stronger than in most species of this subgenus. Endopodite: Posterior bristle of first joint about as long as posterior side of second joint. Second joint: The postero-lateral one of the three bristles on posterior side of this joint has a strong pectination; the medial one of these bristles is about half as long as the postero-lateral, broadly claviform, when seen from the side, with thick walls, naked or almost so, and furnished distally with a narrow spine; spine frequently about half as long as claviform part. Distal lamellæ of this joint somewhat larger than in most species of this subgenus. On medial side of protopodite there is a longitudinal row of fine hairs.

Mandible (text fig. VII, 9-12): Masticatory joint—On toothed edge of pars incisiva the next to the posterior pair of teeth is very small, almost vestigial. On anterior side of dorsal half of this joint there is a rounded hump.

Maxilla (text fig. VII, 13 ♀): The long one of the four dorso-distal bristles on the first joint of the palp usually has hairs of moderate length.

Fifth limb: Relative lengths of joints about as follows:

Protopodite $\frac{10-11}{13.5-14.0}$ Exopodite I. $\frac{6}{7.5}$ II. $\frac{7}{5.5}$ III. $\frac{6}{5.5}$

Protopodite: Bristle on posterior side about as long as distal joint, of moderate strength, not or but slightly swollen at base, more or less distinctly annulated, and furnished with short hairs. End claw with pectination of moderate strength.

Sixth limb: Relative lengths of joints of this limb usually about as follows (scale the one used in fifth limb):

Protopodite $\frac{12}{15}$ Exopodite I. $\frac{7}{9.5}$ II. $\frac{7.5}{6.5}$ III. $\frac{7}{6}$

Of the three bristles on anterior side of protopodite joint, the middle one usually distinctly longer than anterior side of joint; the two others about half as long or somewhat more; bristle on posterior side of this joint of about same type and relative length as in fifth limb of male. Bristle on the first exopodite joint rather weak, often almost naked, and about as long as or slightly shorter than second exopodite joint. End claw slightly stronger than that of fifth limb; its pectination of moderate strength.

Seventh limb: Relative lengths of joints usually about as follows (scale the one used in fifth and sixth limbs):

Protopodite $\frac{12\text{–}13}{15\text{–}16}$ Exopodite I $\frac{9.5\text{–}10.5}{11\text{–}12}$ II $\frac{8}{6}$ III. $\frac{7}{6.5}$

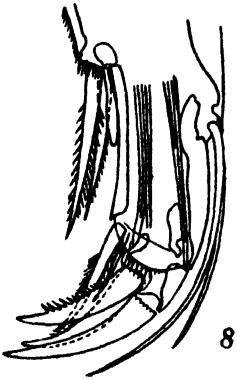
Thus mainly first exopodite joint is more elongated than in sixth limb. Protopodite: Proximal bristle on anterior side of joint vestigial and almost impossible to detect among a number of short hairs; the middle one of bristles on this side rather long, being about as long as this side, or even somewhat more; bristle at the knee about half as long as last-mentioned bristle, or slightly more; bristle on posterior side of this joint relatively long, being about as long as anterior side of joint, or somewhat shorter. Bristle on first exopodite joint of about same type and relative length as corresponding bristle of female sixth limb, or slightly longer.

Brush-shaped organ (text fig. IX, 18): About three to four times as long as wide, of subuniform width throughout its entire length. With a slanting row of short and very fine hairs somewhat distally to middle of organ; this row very difficult to detect even with Reichert's oc.4, Leitz's immers. $^1/_{12}$. Distally this appendage has about thirty to forty bristles which are about as long as appendage, or slightly longer.

Penis (Pl. VI, fig. 1): Apparently very constant in shape and structure. Vas deferens has spiral thickenings.

Text fig. VII. *Cythereis (Cythereis) montereyensis*, n. sp., ♀, not type.

8. Distal part of endopodite of right second antenna from the lateral side. ×425.
9. Right mandible from the medial side. ×520.
10, 11. Bristles just behind anterior tooth of the pars incisiva of the mandible. ×1335.
12. Bristle just behind the next anterior tooth of the pars incisiva of the mandible. ×1335.
13. Distal part of the right maxilla from the medial side; somewhat crushed. ×640. California, Carmel Bay.



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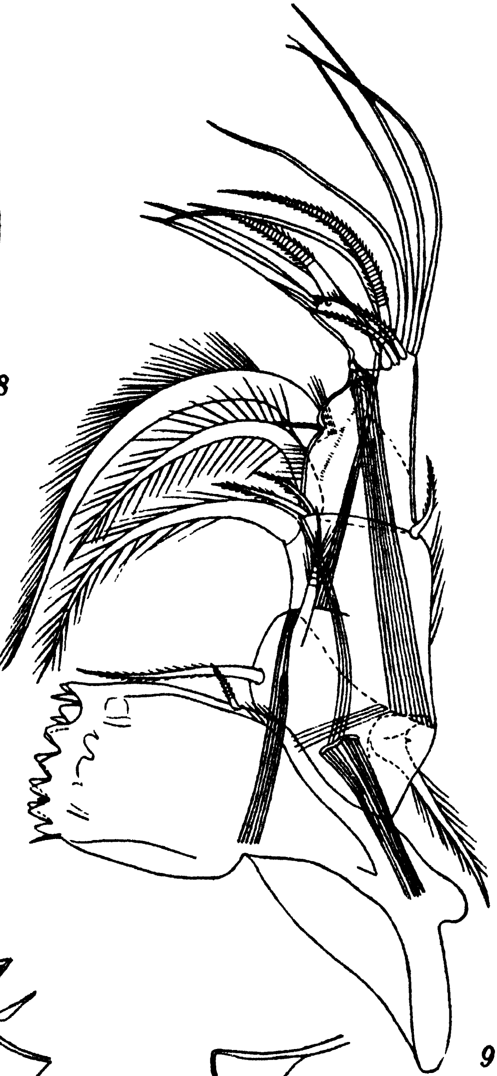

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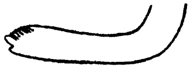

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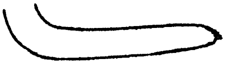

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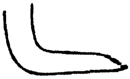

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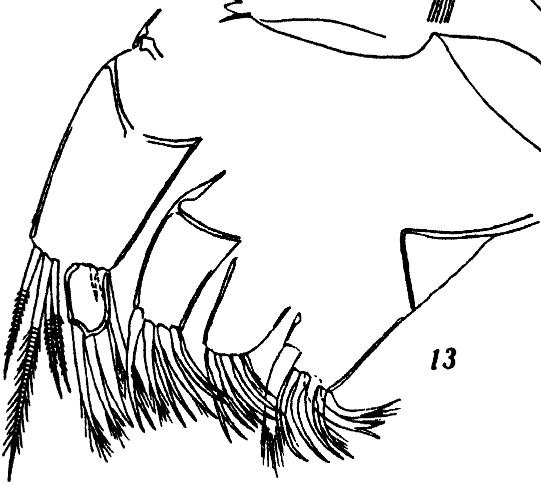


13

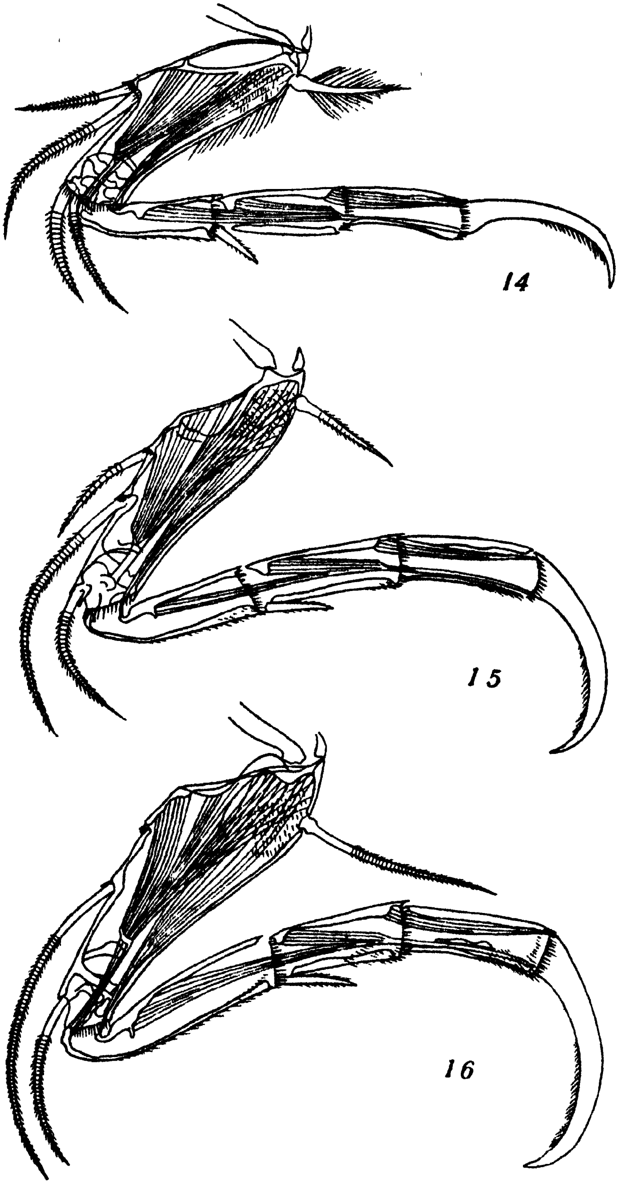
Ductus ejaculatorius has a very long, free tube, bent and curved in a characteristic way; its distal part narrow and whip-like. Copulatory appendage rounded distally and has a decided ventral notch; this appendage has about same type and size in both penes. Penes of small specimens (see below) differed from those of the large mainly in having ductus ejaculatorius kept in a spiral; each spiral with about three coils. For further differences between penes of the large and the small specimens, e.g., in copulatory appendage, reference is made to a comparison between Plate VI, fig. 1 and Plate VI, fig. 2.

Description: Female—

Shell: Length varies usually between 0.64 and 0.67 mm., but some specimens, measuring only 0.58 to 0.60 mm., were found. Length: height, usually about 1.60 to 1.65:1; the small specimens, however, somewhat higher relatively, their ratio being about 1.55 to 1.57:1. Length: breadth, about 2.1-2.2:1. Seen from the side and from below of about same shape as in male. Sculpture of surface in most cases also about same in the two sexes; it seems, however, to be subject to greater variations in female. In some specimens most of the depressions were of moderate size and either irregularly scattered over entire surface, or partly arranged in rows more or less distinctly parallel to margin of shell. In some of these specimens two additional, though rather low, ridges were developed, one somewhat inside dorsal part of anterior margin of shell, the other inside posterior part of dorsal margin of shell. When seen from above, shells of these specimens had somewhat broader extremities than in text fig. VI, 3. The small specimens, mentioned above, were all characterized by the fact that most of the depressions were of moderate size. In other respects female shell agreed with that of male.

Second antenna (text fig. VI, 7 and text fig. VII, 8): The medial one of the three bristles at about middle of posterior side of second endopodite joint usually somewhat longer than in most of the other species of this subgenus, and it has a strong pectination just as the postero-lateral one of these bristles.

Fifth limb (text fig. VIII, 14): Bristle on posterior side of protopodite has about same length as in male, but it is non-



Text fig. VIII. *Cythereis (Cythereis) montereyensis*, n. sp., ♀, not type.
14. Left fifth limb from the lateral side. ×355.
15. Left sixth limb from the lateral side. ×355.
16. Left seventh limb from the lateral side. ×355. California, Carmel Bay.

August 24, 1928

annulated, swollen at base, fine distally, and along greater part of its length it is covered with long, soft hairs.

Sixth limb (text fig. VIII, 15): This differs from that of male in having bristle on first exopodite joint of about same type and strength as corresponding bristle of fifth limb and about half as long as second exopodite joint or slightly longer. (Bristle on posterior side of protopodite thus of same type in both sexes.)

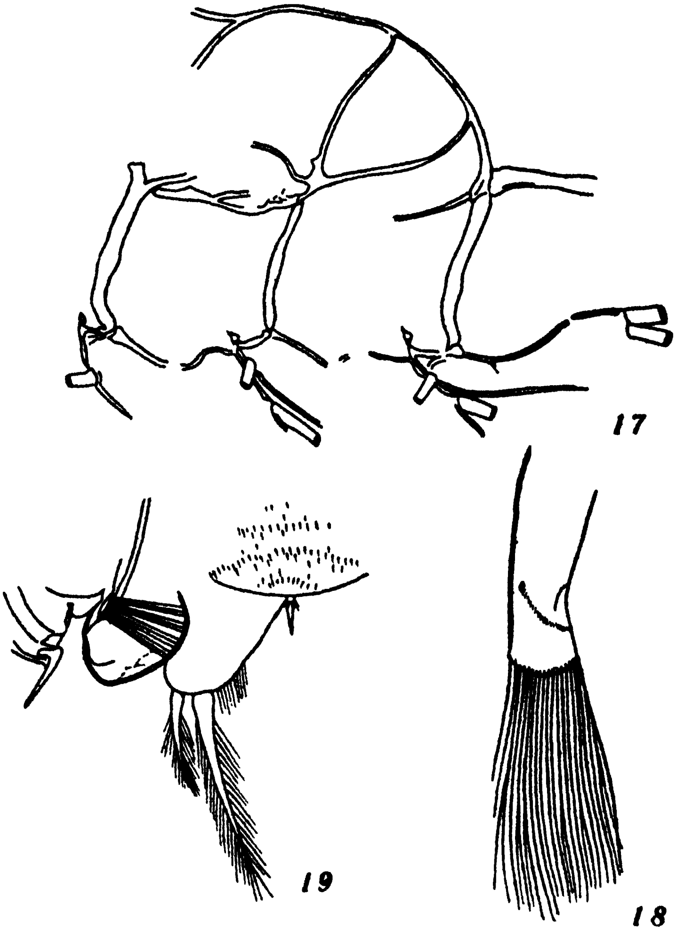
Seventh limb (text fig. VIII, 16): Of about same type as in male.

Posterior part of the back of body has irregular transverse rows of short spines (text fig. IX, 19).

Remarks: As will be seen from the description given above, the sculpture of the shell of this species is subject to rather pronounced variations, especially in the females. The size and the shape of the shell are also rather variable. The remaining organs, on the other hand, are very constant, and it seems probable that the species, in its present scope, represents a natural systematic unit. This assumption is supported by the fact that specimens of different types of shell were found together in nature. (Compare G. W. Müller, 1894, p. 367.)

Among the specimens taken at Carmel Bay and at Pacific Grove, three (and an empty shell) measured only 0.52 mm. in length. These specimens were first considered to be larvæ in the first stage (0.52x1.21 = 0.629; see my paper of 1920, p. 146). Indeed, their lengths agreed perfectly with that of the first larval stage of the other species of this subgenus in which the mature specimens measured about 0.60 to 0.67 mm. in length. When examined, these three specimens proved to be males of mature type and of almost perfectly the same structure as the mature males described above. The free tube of the ductus ejaculatorius, however, was kept in a spiral, which is probably a sign that it had not been used. It seems to me beyond doubt that these specimens should be assigned to the species described above. Were they mature, or did they belong to the first larval stage?

All organs were closely examined in four mature males and three mature females. The shell was measured and examined in all the specimens taken.



Text fig. IX. *Cythereis* (*Cythereis*) *montereyensis*, n. sp., not type.

17. Chitinous support of the fifth, sixth, and seventh limbs, on the right side of the posterior part of the body. Parts below the three simple, subvertical bars belong to these limbs. Fifth limb to the right. Of the proximal bristles of these limbs, only the basal parts are drawn, ♀. ×355.
18. One of the brush-shaped organs; the number of bristles too small, ♂. ×1165.
19. Posterior part of body from the left; somewhat pressed under the cover glass; posterior extremity seen from behind. What is to the left of the genital verruca belongs to the seventh limb, ♀. ×425. California, Carmel Bay.

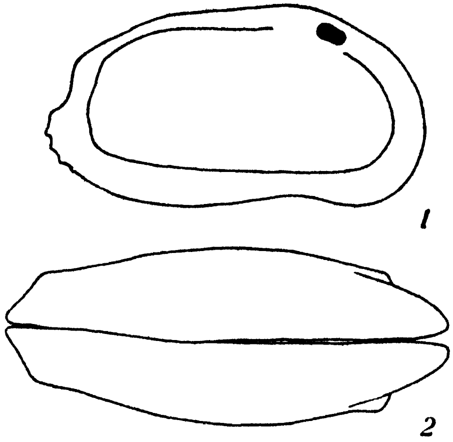
Habitat: **California; Carmel Bay** (type locality)—In tide pool among roots of eelgrass; 23.XI.1920: Eighteen specimens, two of which were males only 0.52 mm. long. At same locality and on same occasion: Two specimens on holdfasts of *Macrocystis.* At same locality, among holdfasts of various sea-weed; 20.I.1921: Two females and one small male (length, about 0.52 mm.). **Pacific Grove,** just outside Hopkins Marine Station: In tide-pool on calcareous algæ; 17.XI.1920: Two females. On roots of eelgrass in tide-pool, 23.XI.1920: One female and one small male (length, 0.52 mm.). On holdfasts of *Macrocystis;* depth, 2 m.; 28.I.1921: One female. All specimens of mature structure and collected by the author.

C. (Cythereis) pacifica, new species

Plate III, fig. 1; Plate VI, fig. 3; text fig. X.

Description: Male—

Shell (Pl. III, fig. 1): Length, 0.60 to 0.64 mm.; length, height, about 1.68-1.75:1; length: breadth, about 2.43-2.50:1. Seen from the side: Left valve; subreniform, with greatest height somewhat in front of middle, and with anterior part distinctly larger than posterior. Dorsal margin, which is evenly and moderately arched, slopes gently posteriorly; anterior margin smooth. Posterior extremity of valve produced somewhat below middle in a distinct, subrectangular, well rounded beak; dorsal part of posterior margin of valve straight to very slightly sinuated; it forms with dorsal margin a broadly rounded, obtuse, but distinct corner. Ventral margin somewhat sinuated in front of middle and slightly arched posteriorly; it joins posterior margin without forming any corner. On ventral part of posterior beak-like process of valve and just antero-ventrally to this, margin is often fringed with about four to six more or less strong teeth. Right valve (text fig. X, 1) differs from the left valve mainly in the following respects: Somewhat smaller; angle above eye more distinct on account of the fact that dorsal part of anterior margin is more depressed. Dorsal part of posterior margin rather strongly sinuated, sometimes even slightly more than in the accompanying figure; this makes dorsal corner of beak-



Text fig. X. *Cythereis* (*Cythereis*) *pacifica*, n. sp., ♂.
1. Right valve from the side, type. ×81.
2. Shell from below; front end to the left (not type). ×95.
Pacific Grove, California.

like process and postero-dorsal corner of valve more pronounced. Ventral margin more sinuated in front of middle. Seen from below (text fig. X, 2): Widest at or just behind middle; posterior part of shell about as large as or but slightly larger than anterior. Gently and evenly convex in middle; nearly straight to slightly concave in front of middle; on each valve with an obtuse, rounded angle near anterior extremity; behind middle side contours form an evenly rounded curve which is broken somewhat in front of posterior extremity by a slight projection (caused by postero-dorsal ridge); posterior extremity narrowly rounded. Sculpture of surface rather constant. Somewhat inside of, and about parallel to, anterior margin, there is a rather broad and low, rounded ridge which runs from eye to a point somewhat below middle of shell; near middle of anterior margin it has a short, low, and spur-like posterior continuation. Ventral ridge one-sided and rather low; its ventral slope is more or less concave, it continues along entire ventral margin of shell, and ends at postero-ventral beak-like process. On posterior half of shell another one-sided but more marked ridge runs at some distance from, and about parallel to, dorsal margin and dorsal part of posterior margin of shell; it forms a distinct but rounded corner inside postero-dorsal corner of shell, and its dorsal and posterior slopes are always steep; as far as my experience goes, it never joins ventral ridge, and it seems always to be more or less distinctly bifurcated anteriorly. Just behind eye there is, in most cases, a low, short ridge which runs slantingly upwards and backwards. Antero-dorsal quadrant of shell, inside the ridges, covered with rather numerous, small, rounded depressions, usually arranged in five to six more or less irregular rows running slantingly upwards and backwards. In antero-ventral quadrant, inside the ridges, five to six similar rows occur running more or less parallel to ventral ridge. In postero-dorsal quadrant, inside the dorsal ridge, there are two longitudinal rows of rather large and deep depressions, about five depressions in each row (posterior depression considered to belong to ventral row); some of these depressions divided into two or more smaller depressions. In postero-ventral quadrant, inside the ridges, a number of rather large and deep depressions are to be found, usually arranged in about the way shown in Plate III, fig. 1; their sizes, number, and arrangement, however, subject to some variation. Dorsal and ventral quadrants separated by a longitudinal zone, which either is almost smooth, or is covered with rather widely-spaced, scattered and small depressions. Anterior and postero-dorsal ridges in most specimens almost smooth. Outside the ridges surface of shell either nearly smooth, or it is covered with scattered depressions of different sizes and number; along dorsal margin of shell, however, depressions are more or less distinctly arranged in rows; these rows usually not quite so regular as in the figure. Hairs along margin and color of shell about as in *C. (C.) montereyensis.* No dark fields are to be detected, when shell is regarded by transmitted light (of course, with the exception of ridges and zone between dorsal and ventral quadrants).

First antenna: Fourth joint somewhat more elongated than in *C. (C.) montereyensis,* being about $\frac{9}{7}$, expressed in scale used in description of the subgenus. No longitudinal rows of hairs seem to occur on first joint.

Second antenna: Of about same size and strength as in *C. (C.) montereyensis.* Endopodite: Posterior bristle of first joint almost as long as posterior side of second joint. Second joint: The group of three bristles on posterior side of this joint situated slightly more proximally than in *C. (C.) montereyensis;* its postero-lateral bristle furnished with rather strong pectination; the remaining two bristles of this group have about same types and sizes as in *C. (C.) platycopa;* the sensorial one, however, somewhat smaller. In some specimens there seems to be no longitudinal row of hairs on medial side of protopodite.

Mandible: On toothed edge of pars incisiva, the next to the posterior pair of teeth is very small. There is a rounded hump on anterior side of dorsal half of masticatory joint. The row of hairs on medial side of second endopodite joint seems to be represented only by a small group of hairs of moderate length somewhat proximally to distal boundary of joint.

Maxilla: The long one of the four dorso-distal bristles of first joint of palp has short hairs or is almost naked.

Fifth limb: Relative lengths of joints about same as in *C. (C.) montereyensis.* Walls of joints sometimes not quite so strong as in this species. Types and relative lengths of bristles about as in male of the mentioned species; end claw, however, finely pectinated.

Sixth limb: Relative lengths of joints and types and relative lengths of bristles about as in *C. (C.) montereyensis;* pectination of end claw, however, very weak.

Seventh limb: Of about same type as in *C. (C.) montereyensis;* long bristles of protopodite, however, as a rule, slightly shorter relatively.

Brush-shaped organ: Of a type intermediate between that of *C. (C.) montereyensis* and that of *C. (C.) platycopa.*

Penis (Pl. VI, fig. 3): Vas deferens with spiral thickening. Ductus ejaculatorius has a free tube of moderate length and somewhat S-shaped type. Copulatory appendage fairly large, of about same shape on both penes, rounded distally, with ventral notch near distal end.

Description: Female—

Shell: Length, about 0.61 to 0.65 mm. Similar to that of male, but slightly higher and broader relatively; sometimes it agrees even in these respects with male shell.

Second antenna: The medial one of the three bristles at about middle of posterior side of second endopodite joint seems usually to be less strongly pectinated than postero-lateral bristle of this group.

Fifth limb: Types and relative lengths of bristles about same as in *C. (C.) montereyensis*, ♀.

Sixth limb: Types and relative lengths of bristles about same as in *C. (C.) montereyensis*, ♀; pectination of end claw, however, rather weak.

Seventh limb: Of about same type as in male.

Genital verruca and posterior part of body about as in *C. (C.) montereyensis.*

Remark: All organs carefully examined in three males and two females; shells of all recorded specimens examined.

Habitat: **California; Pacific Grove,** just outside Hopkins Marine Station (type locality)—In tide-pool, on calcareous algæ; 17.XI.1920: One mature male (dead, when taken). On holdfast of *Macrocystis;* depth, about 2 m.; 23.XI.1920: Four dead mature specimens, seven living mature specimens, and four juvenes, 0.52 to 0.54 mm. long. **Carmel Bay:** On holdfasts of kelp near shore; 23.XI.1920: One dead mature male and two living females. In tide-pool, on roots of eel-grass; 20.I.1920: Three dead mature specimens. Males and females occurred in about equal number; all specimens taken by the author.

Tæniata Group nov.

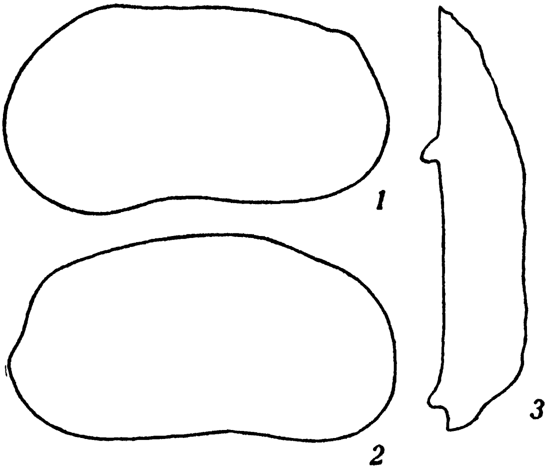
This group comprises *C. (C.) tæniata, tæniata* var. *deliciosa,* and *longiductus.*

C. (Cythereis) tæniata, new species

Plate I, fig. 6; Plate IV, fig. 5; text fig. XI.

Description: Male—

Shell: Length, 0.61 to 0.63 mm.; length: height, about 1.8:1; length: breadth, about 2.6:1. Seen from the side: Left valve (text fig. XI, 1): Greatest height situated somewhat in front of middle, at about anterior hinge-tooth; valve, however, only slightly higher anteriorly than posteriorly. An-



Text fig. XI. *Cythereis* (*Cythereis*) *tæniata*, n. sp., ♂, type.
1. Left valve from the side. ×82.
2. Right valve from the side. ×82.
3. Left valve from above. ×90. Falkland Islands, S. A. E., station 46.

terior margin without teeth or crenulation. Posterior margin forms almost an arc with posterior part of ventral margin, its dorsal half flattened, almost straight; without distinct teeth or serrulation, sometimes, however, somewhat uneven. Dorsal margin gently arched, with slight sinuation just behind anterior hinge-tooth and in front of posterior hinge-socket; it slopes gently posteriorly and forms with posterior margin a distinct but broadly rounded corner. Ventral margin somewhat sinuated in front of middle, its posterior half almost straight. Right valve (text fig. XI, 2): This differs from left mainly in the following respects. Sometimes of about same size as the left, but in many specimens distinctly lower (length: height, sometimes about 2:1). Anterior margin somewhat more flattened dorsally, and dorsal part of posterior margin slightly sinuated. Dorsal margin without the slight sinuation just behind anterior and just in front of posterior hinge-tooth. Outlines of the two valves not constant, variations from type described above, however, rather slight. Seen from above (text fig. XI, 3): Outline somewhat irregular;

sides sub-parallel, converging gently towards anterior and rather abruptly towards posterior extremity; anterior extremity somewhat pointed, posterior irregularly rounded. Sculpture of surface rather constant; slight variations, however, to be noted in number, shapes, sizes, and development of depressions, as well as in development, shapes, and positions of main ridges. Just inside, and about parallel to, anterior margin of shell, there is a low and rather narrow ridge. Ventral ridge fairly low; indeed, along posterior half of ventral margin of shell, it frequently is not developed at all. At a rather great but somewhat varying distance from posterior margin of shell and more or less parallel to this, there is a one-sided ridge, usually rather distinct and sometimes fairly straight, sometimes more or less sinuated inside middle of posterior margin of shell; this ridge continues along posterior half of dorsal margin, which it does not cover when shell is observed from the side; at about middle, this posterior ridge has a low and fairly narrow, spur-like continuation, which runs about parallel to longitudinal axis of shell to a point somewhat behind middle of shell. This spur furnished with a row of rather small excavations, either simple or divided into two to five small pits. Rest of surface covered with closely-set, angular excavations of moderate size and depth; excavations just above the noted spur-like zone arranged in two rows parallel to longitudinal axis of shell; the others are situated more or less irregularly. Bottoms of most of these excavations marked by a somewhat varying number of small pits. Among the hairs along anterior margin and along anterior part of ventral margin of shell, some are of the ordinary narrow, simple type, some (about twenty to twenty-eight) are hyaline, flattened, leaf-like, and either with smooth edges or with very short and fine hairs along one edge. Along posterior part of ventral margin and along posterior margin of shell, there is a number of rather short bristles; nearly all of these are of ordinary, simple, narrow type, or some of them are slightly flattened. When seen by transmitted light, shell is brownish (specimens preserved in alcohol); when dried and seen by reflected light, it is porselaneous. No dark areas are to be detected, when shell is observed by transmitted light (of course, with the exception of ridges).

First antenna: Fourth joint slightly more elongated than in *C. (C.) montereyensis,* being about $\frac{7.5}{6}$, expressed in scale used in description of the subgenus. Bristle in front of proximal claw of fourth joint about one-quarter to one-sixth shorter than this claw. On medial side of first joint there is a row of hairs of about same type as in *C. (C.) montereyensis;* on lateral side of this joint there seems to be no longitudinal row of hairs; long hairs on anterior side of second joint somewhat less numerous than in the mentioned species.

Second antenna: Second endopodite joint: All bristles of this joint have about same position as in Plate XXXV, fig. 19, G. W. Müller, 1894. Those at the middle of posterior side of this joint have about same types as in female; the medial and postero-lateral ones of them have rather fine pectination. The strong postero-distal bristle on this joint is relatively weak and very finely pectinated. Distal plates of this joint rather small, with fine pectination on medial side of appendage and pectination of moderate strength on lateral side. At base of distal claw of end joint, no spines, or only very weak, scarcely distinguishable, spines are developed. On medial side of the protopodite there is a row of hairs as in *C. (C.) montereyensis.*

Mandible: On toothed edge of pars incisiva of masticatory joint, the next to the posterior pair of teeth is about as large as adjoining pairs. There is no rounded hump on anterior side of dorsal part of this joint. The row of hairs on medial side of second endopodite joint seems, at least sometimes, to be made up of hairs somewhat longer than in text fig. VII, 9 of *C. (C.) montereyensis.*

Maxilla: The long one of the four dorso-distal bristles of first joint of palp seems usually to be furnished with hairs of moderate length.

Fifth limb: Of about same type as in *C. (C.) montereyensis,* ♂.

Sixth limb: Of about same type as in *C. (C.) montereyensis,* ♂. The middle one of the three bristles on anterior side of protopodite about as long as this side. Bristle of first exopodite joint about as long as to slightly longer than second joint.

Seventh limb: Of about same type as in C. *(C.) glauca*, ♂. Bristle on posterior side of protopodite sometimes about one-half as long as in text fig. VIII, 16 of C. *(C.) montereyensis.*

Chitinous support of these three limbs, on sides of posterior part of body, usually somewhat stronger than in C. *(C.) montereyensis.*

Brush-shaped organ: Of about same type as in C. *(C.) montereyensis*, but somewhat broader and more rounded distally than in figure 18 of this species.

Penis (Pl. IV, fig. 5): Vas deferens with spiral thickening. Free tube of ductus ejaculatorius of moderate length and extends to about distal point of copulatory appendage. Copulatory appendage has a narrow, beak-like postero-ventral projection, which is narrowly rounded distally; its anterior part, which is somewhat variable in shape, is obliquely rounded and somewhat truncated distally; in right penis its distoventral extremity is bent in, and under the cover-glass it is pressed against inner side of appendage (always ?).

Description: Female—

Shell: Length, 0.61 to 0.64 mm.; length: height, about 1.7:1. Seen from the side of about same shape as in male, but slightly higher relatively and with slightly more arched dorsal margin. Seen from above slightly broader relatively and with less flattened sides than in male. In other respects about as in male (Pl. I, fig. 6).

Second antenna: Protopodite and endopodite about as in male.

Fifth limb: Of about same type as in C. *(C.) montereyensis*, ♀.

Sixth limb: Of about same type as in C. *(C.) montereyensis*, ♀, but bristle on posterior side of protopodite of about same type and size as corresponding bristle of fifth limb; and the middle one of the three anterior bristles of this joint about as long as anterior side of this joint.

Seventh limb: Of about same type as in C. *(C) glauca*, ♀.

Genital verruca and posterior part of body about as in C. *(C.) montereyensis*, ♀; the former slightly flattened postero-ventrally; the latter almost lacks spines, and the bristle of its posterior extremity situated on a rather small, rounded process.

Remark: Two males, two females, and the shells of all the recorded specimens were examined.

Habitat: **Falkland Islands**—S.A.E., Station 46, **Port Louis, Carenage Creek,** lat. 51° 32′ S., long. 58° 7′ W. (type-locality); 9.VIII. 1902; depth, 1 m.; sand with *Codium:* Three mature males and eighteen mature females. S.A.E. Station 51, **Port William**; 3.IX. 1902; depth, 22 m.; sand: Two mature males.

C. (Cythereis) tæniata, new species var. deliciosa, new var.

Plate I, fig. 7.

Description: Female—

Shell (Pl. I, fig. 7): Length, 0.69 mm.; length: height, about 1.72:1; length: breadth, about 2:1. Seen from the side of about same shape as in *C. (C.) tæniata,* ♀. Seen from above also of about same shape as in this species; however, not so much flattened at the sides, but with fairly well arched outline in middle (about as in plate 20, figure 3b, *Cythere subrufa,* G. S. Brady, 1880, but posterior ridge slightly more prominent). Sculpture of surface very beautiful and approaches that of *C. (C.) tæniata.* Ventral main ridge one-sided and well developed along entire ventral margin. Posterior main ridge, which also is one-sided and well developed, runs slantingly upwards and forwards to about middle of dorsal margin of shell, is somewhat sinuated just dorsally to middle of shell, and joins ventral ridge, with which it forms a well rounded corner. When shell is regarded from the side, dorsal part of posterior main ridge does not cover, or even touch, dorsal margin of shell. Somewhat inside, and about parallel to, anterior margin, there are two narrow and rather low ridges, one somewhat inside of the other; the inner one runs from eye downwards, and they (always ?) join just in front of main ventral ridge. From about middle of posterior main ridge, a somewhat irregular, rather broad, and slightly elevated longitudinal zone runs towards ventral part of inner anterior ridge; this zone marked by a number of more or less scattered small pits. Rest of surface of shell covered with closely-set irregular excavations of moderate size, most of them of moderate depth, some, especially on anterior part of shell, rather shallow. Bottoms of excavations with a varying number of small pits. Hairs along margin of shell about as in *C. (C.) tæniata.* No dark areas are to be seen, when shell is regarded by transmitted light (of course, with the exception of ridges).

First antenna: Differs from that of *C. (C.) tæniata* in having an irregular longitudinal row of hairs on lateral side of first joint. This character, however, probably not constant.

Remaining organs have the same type as in *C. (C.) tæniata.*

Remarks: This form is structurally very close to *C. (C.) tæniata.* Indeed, the examined females of these two forms differ only in the length and sculpture of the shell; and the differences established are not very pronounced. On the other hand, an examination of the male may prove these two forms to be specifically distinct, since the females of this subgenus frequently are much less differentiated than the males. In other words, the systematic position of this form can not be settled until several specimens of both sexes have been carefully examined. It may be but a modification, or it may be a distinct species. The fact that the two forms have been taken at different localities appears to indicate their systematic independence.

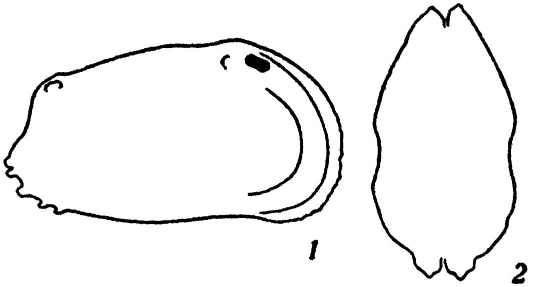
Habitat: **Tierra del Fuego, Puerto Harris**; 11.III.1896: One mature female (S.M.E.).

C. (Cythereis) longiductus, new species

Plate I, fig. 8; Plate IV, fig. 6; text fig. XII.

Description: Male—

Shell (Pl. I, fig. 8): Length, 0.86 to 0.89 mm.; length: height, about 1.9:1; length: breadth, about 2:1. Seen from the side: Left valve: Of about same shape as in *C. (C.) megalodiscus.* Ventral part of anterior margin and anterior part of ventral margin furnished with a fine, more or less distinct, crenulation. Hump above eye sometimes even, as in Plate II, fig. 4 of *C. (C.) megalodiscus,* sometimes about as in Plate I, fig. 8. Sinuation just in front of posterior hinge-tooth sometimes scarcely developed. Posterior margin usually slightly sinuated in middle; on, and just antero-ventrally to, beak-like posterior process of valve, there are about five to seven rather strong teeth. Ventral margin sometimes slightly sinuated in front of middle. Right valve (text fig. XII, 1): Of about same shape as the left; hump above eye, however, somewhat less developed, and dorsal part of posterior margin of valve a little more sinuated. As a rule, ventral margin also slightly more sinuated in front of middle. Seen from below (text fig. XII, 2): Also of about same shape as in *C. (C.) megalodiscus;* usually somewhat sinuated in middle. Sculpture of surface: Seems to be rather constant. Ventral main ridge, which is well developed along entire ventral margin of shell, has narrow edge. Posterior main ridge narrow and of moderate height to rather low; in most cases it joins ventral main ridge, with which it forms a rounded corner somewhat inside beak-like postero-ventral process of shell; in all specimens examined it was somewhat sinuated dorsally to middle. Dorsally, this ridge joins two ridges; first, a narrow ridge of moderate height running along and, when shell is seen from the side, in some specimens partly covering, posterior half of dorsal margin of shell; and, second, a similar ridge which runs just inside posterior margin of shell. Somewhat inside, and about parallel to, anterior margin of shell, there is a narrow ridge of moderate height. Surface of shell covered with closely-set, angular excavations of moderate size and depth; ridges between excavations narrow. Some of these ridges are slightly more elevated than the others; one of these more elevated ridges runs from the sinuation of posterior main ridge



Text fig. XII. *Cythereis (Cythereis) longiductus,* n. sp., ♂, not type.
1. Right valve from the side. ×50.
2. Shell from below; front end up. ×41. South Georgia, S. A. E., station 25.

across shell, towards a point somewhat ventrally to middle of anterior margin of shell; just in front of posterior main ridge it often gives off a branch, which runs steeply towards ventral main ridge. From anterior part of postero-dorsal main ridge, a usually bifurcated ridge runs obliquely downwards and forwards. Course of these ridges slightly variable, and in some specimens some of them are not more elevated than the ordinary ones. Bottoms of excavations fairly smooth. Along ventral half of anterior margin and along anterior part of ventral margin of shell, there are about twenty to thirty simple, hyaline, leaf-like bristles; along margin of posterior part of shell, a few simple, narrow bristles occur. No dark fields are to be detected, when shell is regarded by transmitted light.

First antenna: Fourth joint rather much more elongated than in *C. (C.) montereyensis*, being about $\frac{9.5\text{–}10.0}{8.5\text{–}9.0}$, according to scale used in description of the subgenus. Claws of fourth joint relatively long, being somewhat longer than posterior side of second joint. Pilosity about same as in *C. (C.) montereyensis;* hairs on anterior side of second joint, however, somewhat scarcer.

Second antenna: Positions of bristles about same as in Plate XXXV, fig. 19, G. W. Müller, 1894. The three bristles at about middle of posterior side of second endopodite joint have about same types as in female; the postero-lateral and the medial of these bristles with pectination of moderate strength. It should be noted, however, that of the two last-mentioned bristles, the medial is somewhat longer than the postero-lateral in the male; while in the female (as in males and females of all the other species of this subgenus which I have had the opportunity of examining), the postero-lateral is somewhat longer than the medial. The antero-lateral, sensorial, one of these three bristles has about type shown in text fig. XVI, 3 of *C. (C.) ephippiata.* Postero-distal bristles of this joint and the three claws of distal joint also of about same types and relative lengths as in this figure; postero-lateral end claw, however, slightly weaker and shorter than postero-medial end claw. Pilosity: On lateral side of protopodite there are more or less scattered, short, fine hairs; on medial side of this joint a longitudinal row of fine hairs occurs. Pectination of distal plates of second endopodite joint rather fine on medial side of joint and of moderate strength on lateral side.

Mandible: Masticatory joint—Toothed edge of pars incisiva of about same type as in *C. (C.) montereyensis.* No hump on anterior side of dorsal part of this joint. Endopodite: Of the four ventro-distal bristles of first joint found in most species of this subgenus, one of the two shorter is always absent. Hairs of the longitudinal row of hairs on medial side of second joint sometimes about as short as in the mentioned species, sometimes a little longer.

Maxilla: The long one of the four dorso-distal bristles of first joint of palp usually has hairs of moderate length.

Fifth limb: Of about same type as in *C. (C.) montereyensis,* ♂ ; or exopodite perhaps slightly longer, when compared with protopodite, than in this species. Bristle on posterior side of protopodite slightly longer relatively. Bristle of first exopodite joint about half as long as second exopodite joint, or rather slightly shorter. End claw slightly longer relatively and almost naked.

Sixth limb: Of about same type as in *C. (C.) montereyensis,* ♂, with the same reservations as to relative lengths of exopodite, the bristle on posterior side of protopodite, and end claw, as in the case of fifth limb. Bristle of first exopodite joint slightly shorter than second exopodite joint.

Seventh limb: Of about same type as in *C. (C.) montereyensis.* The following differences to be noted: First exopodite joint somewhat more elongated. The proximal one of the three bristles on anterior side of protopodite about half as long as height of exopodite joints; the middle one of these bristles about as long as anterior side of protopodite. Bristle of first exopodite joint of about same relative length as in the mentioned species, has short hairs, and is almost as weak as corresponding bristle on sixth limb. End claw, just as in fifth and sixth limbs, perhaps slightly longer and weaker relatively and has fairly weak pectination.

Brush-shaped organ: Of about same type as in *C. (C.) montereyensis.*

Penis (Pl. IV, fig. 6): Of about same type as in *C. (C.) tæniata.* The following differences should be noted: Copulatory appendage, which has about same type in right and left penes, is slightly longer relatively and more narrowly rounded distally; its postero-ventral process somewhat longer. Free part of ductus ejaculatorius very long, a character from which the species has received its name; at its base it has a lamelliform, free, rather narrow appendage, kept on inside of copulatory appendage; in accompanying figure its point does not quite reach anterior point of copulatory appendage.

Description: Female—

Shell: Length, about 0.92 mm.; length: height, about 1.8:1; length: breadth, about 1.8:1. Of about same type as male shell, but slightly higher and broader relatively. In female examined, outline of shell, seen from below, was rather slightly sinuated in middle.

Second antenna: Of about same type as in male, with the usual exceptions in exopodite and in relative lengths of the postero-lateral and the medial of the three bristles at about middle of posterior side of second endopodite joint.

Mandible: In the only specimen examined, one of the two short ventro-distal bristles of first endopodite joint was absent, just as in male.

Fifth limb: Of about same type as in male. Bristle on posterior side of protopodite, however, similar to corresponding bristle in *C. (C.) montereyensis,* ♀.

Sixth limb: Of about same type as in male, but bristle on posterior side of protopodite has approximately the type of the corresponding bristle of fifth limb; and bristle of first exopodite joint has same type and relative length as in *C. (C.) montereyensis,* ♀.

Seventh limb: Of about same type as in male. In the single specimen examined, bristle on posterior side of protopodite was somewhat shorter than in male; and bristle of first exopodite joint had about same type as in *C. (C.) montereyensis* and was nearly as long as second exopodite joint.

Genital verruca and posterior part of body about as in *C. (C.) montereyensis;* no spines, however, were detected on back of posterior part of body, and opening on genital verruca had somewhat thicker margins.

Remark: One complete and three incomplete males, and one complete female examined.

Habitat: **South Georgia**—S.A.E., Station 25, off **Grytviken;** lat. 54° 22′ S., long. 36° 27′ W. (type-locality); 21.V.1902; depth, 24-52 m.; grey clay with scattered algæ; four mature males (only one of which was alive when taken), one mature female (alive when taken), and two juvenes. S.A.E. Station 28, mouth of **Grytviken,** lat. 54° 22′ S., long. 36° 28′ W.; 24.V.1902; depth, 12-15 m.; sand and algæ: one mature male (dead when taken).

Discophora Group nov.

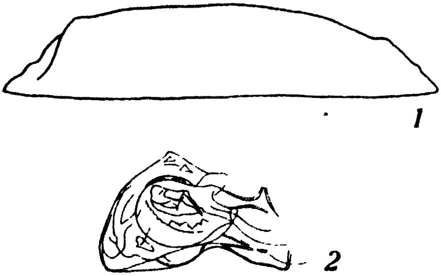
This group is very uniform and comprises three of the species described in this paper, viz., *C. (C.) discophora, mesodiscus,* and *megalodiscus.*

C. (**Cythereis**) **discophora** new species

Plate II, fig. 1; text fig. XIII.

Description: Male—

Shell: Length, 0.66 to 0.68 mm.; length: height, about 2.0-2.1 :1. Seen from the side of about same shape as in *C. (C.) glauca.* Posterior part of dorsal margin, however, not covered by any ridge, and margin of shell smooth, i.e., without any teeth or crenulation. Ventral margin seems, in most specimens, to be somewhat less sinuated in front of middle than in the mentioned species. Sculpture of surface rather constant: slight variations occur, however, in number, sizes. and positions of excavations, as well as in development of main ridges. Ventral and posterior main ridges, which are one-sided, sometimes have rather broadly rounded edges; most frequently they are united somewhat in front of posteroventral corner of shell; and from their point of union a low, spur-like, rather narrow ridge issues to edge of the mentioned corner of shell. Anteriorly, ventral ridge is continued by a low and rather narrow ridge, which runs about parallel to and at a rather great distance from anterior margin of shell as far as to eye. No other main ridges are developed. Surface of shell covered with numerous closely-set, rounded or more or less angular excavations of moderate size and depth; surface just outside muscle-spots has, however, but a few, rather small pits. Excavations arranged rather irregularly. Among bristles along anterior margin and along anterior part of ventral margin of shell, about 25 to 35 are rather short, hyaline, flattened, and leaf-like, and their edges have short and fine hairs. Along posterior part of ventral margin and along posterior margin of shell, there is a moderate number of rather short, simple, narrow bristles. When seen by transmitted light, the shells (of specimens preserved in alcohol) have a light brownish color. No dark fields are to be seen, of course, with the exception of ridges.



Text fig. XIII. *Cythereis* (*Cythereis*) *discophora*, n. sp., not type.
1. Left valve from above, ♀. ×84.
2. Copulatory appendage of right penis from the medial side. ×215. Falkland Islands, S. A. E., station 46.

First antenna: Fourth joint somewhat more elongated than in *C.* (*C.*) *montereyensis*, being about $\frac{8}{7}$, according to scale used in description of the subgenus. Bristle in front of posterior claw of fourth joint slightly shorter relatively than in the mentioned species. On first joint there is an irregular, longitudinal row of hairs both on medial and on lateral side.

Second antenna: Bristle on first endopodite joint somewhat shorter than in *C.* (*C.*) *montereyensis*. Second endopodite joint: Positions of bristles on this joint about as in Pl. XXXV, fig. 19, G. W. Müller, 1894. The posterolateral and the medial ones of the three bristles at about middle of posterior side of this joint about as in *C.* (*C.*) *mesodiscus*, and furnished with rather few and moderately strong, spine-like hairs. Pilosity of protopodite about as in *C.* (*C.*) *montereyensis*, but an irregular longitudinal row of hairs occurs on lateral side. Spines of distal plates of second endopodite joint rather weak on medial side and rather strong on lateral side of joint. There seems to be no spines at base of anterior end claw.

Mandible: Masticatory joint: The next to the posterior pair of teeth of pars incisiva somewhat larger relatively than in text fig. VII, 9 of *C. (C.) montereyensis.* The next to the anterior tooth of this edge is paired, and sometimes a few of the paired teeth are more or less bifurcated. No rounded hump on anterior side of dorsal half of this joint. Epipodial appendage: The peg-like appendage has rather long, fine hairs. Endopodite: The strong ventro-distal bristles of first joint usually somewhat weaker than in text fig. VII, 9 of *C. (C.) montereyensis.* The row of hairs on medial side of second endopodite joint made up of rather long hairs; most of these about as long as height of end joint.

Maxilla: Of the four dorso-distal bristles on first joint of palp, the long one is furnished with hairs of moderate length.

Fifth limb: This limb is somewhat more slender than in *C. (C.) montereyensis;* relative lengths of joints about same as in *C. (C.) montereyensis.* Bristle on first exopodite joint somewhat more slender than in this species; remaining bristles about as in male of this species. Pectination of end claw as well as distal pectination of joints rather weak.

Sixth limb: Exopodite slightly longer relatively and somewhat more slender than in *C. (C.) montereyensis.* The middle one of the three bristles on anterior side of protopodite about as long as this side. Other bristles about as in *C. (C.) montereyensis,* ♂ ; end claw, however, slightly weaker, and with rather weak pectination. Distal pectination of joints also rather weak.

Seventh limb: Relative lengths of the joints:

Protopodite $\frac{11}{14}$ Exopodite I. $\frac{11.5}{12.5}$ II. $\frac{7}{6}$ III. $\frac{7}{6.5}$

Exopodite somewhat more slender than in *C. (C.) montereyensis.* Protopodite: Proximal bristle on anterior side unusually well developed, about as long as half the height of exopodite joints or even slightly more. Other bristles of this joint slightly shorter than in *C. (C.) montereyensis.* Bristle on first exopodite joint has same slender type as in fifth and sixth limbs of male, and is about half as long as second exopodite joint or somewhat longer. End claw slightly weaker than in the mentioned species.

Chitinous support of these three limbs, on the sides of posterior part of body, characterized by the fact that some of the stripes frequently are distinctly broader than in *C. (C.) montereyensis.*

Brush-shaped organ: About intermediate between that of *C. (C.) montereyensis* and that of *C. (C.) platycopa.*

Penis: Of about same type as in *C. (C.) mesodiscus,* but discus-shaped plate somewhat different and smaller (text fig. XIII, 2). Outline of copulatory appendage somewhat variable, sometimes of about type shown in the mentioned figures, sometimes about as in figure of *C. (C.) mesodiscus.* I am not quite sure whether there is any difference between this species and *C. (C.) mesodiscus* in chitinous skeleton just behind copulatory appendage, since this skeleton is not only extraordinarily complicated but also somewhat variable; fundamental type, however, the same in both species.

Description: Female—

Shell (text fig. XIII, 1, and Pl. II, fig. 1): Length, 0.66-0.69 mm.; length: height, about 1.8-1.9:1; length: breadth, about 2.1:1: Seen from the side, of about same shape as in male, but, as will be seen from figures given above, somewhat higher relatively. Ventral margin seems to be somewhat more sinuated in front of middle. Seen from above, shell is widest at about middle, with a somewhat irregular outline, gently tapering towards anterior extremity, and more abruptly posteriorly. Posterior ridge forms a more or less marked projection. In other respects of about same shape as in male.

Second antenna: Exopodite: Somewhat shorter than in most of the remaining species of this subgenus; about 1.5 to 2.0 times longer than anterior side of first endopodite joint and of about same type as in *C. (C.) ephippiata.*

Fifth limb: Of about same type as in *C. (C.) montereyensis,* ♀.

Sixth limb: This differs from that of male mainly in the following respects: Bristle on posterior side of protopodite of about same type as corresponding bristle of female fifth limb. Bristle of first exopodite joint of about same type and relative length as in *C. (C.) montereyensis*, ♀, but slightly weaker (perhaps also slightly shorter) relatively.

Seventh limb: Differs from that of male chiefly in bristle of first exopodite joint, which is of about same type as in *C. (C.) montereyensis* but slightly weaker.

Genital verruca and hind part of body of about same type as in *C. (C.) montereyensis;* however, no rows of spines were detected on back of posterior part of body.

Remark: Three males and four females were examined.

Habitat: **Falkland Islands**—S.A.E., Station 46, **Port Louis, Carenage Creek,** lat. 51° 32′ S., long. 58° 7′ W. (type-locality); 9.VIII.1902; depth, 1 m.; sand with *Codium:* Four males and seventeen females, all mature.

C. (Cythereis) mesodiscus, new species

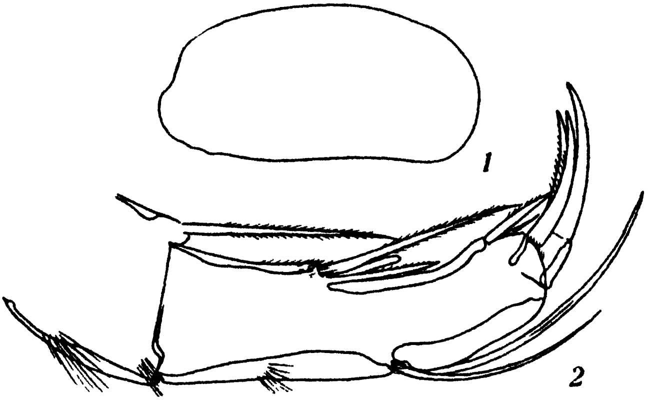
Plate II, figs. 2 and 3; Plate IV, fig. 7; text fig. XIV.

Description: Male—

Shell (Pl. II, figs. 2 and 3; text fig. XIV, 1): Length, about 0.78 mm.; length: height, about 2:1; length: breadth, about 2.35:1. Seen from the side: Left valve: Oblong, greatest height at about anterior hinge-tooth, anterior half distinctly larger than posterior. Anterior margin smooth. Dorsal margin evenly and slightly convex, sometimes almost straight; slopes gently posteriorly, sometimes with a slight depression just behind anterior hinge-tooth. Posterior extremity produced below middle in a nearly rectangular, broadly rounded beak; dorsal part of posterior margin slightly arched to almost straight, and forms with the dorsal margin a broadly rounded but distinct corner. Ventral margin almost straight to rather slightly sinuated in front of middle and joins the posterior without forming any corner. Edge of beak-like postero-ventral process smooth, or almost so; but just antero-ventrally to beak there are two very low and rounded teeth. Right valve: Differs from left mainly in the following respects: Anterior margin somewhat more flattened dorsally (sometimes slightly more than in text fig. XIV, 1) which makes corner above eye somewhat more distinct. Dorsal part of posterior margin distinctly sinuated, not, however, always so much as in text fig. XIV, 1. Dorsal margin, at least in some specimens, somewhat more arched. Seen from above, shell is somewhat varying in shape; of about shape shown in Pl. XIII, fig. 6f *(Cythere flabellicostata)*, G. S. Brady, 1880; flattened at sides; sometimes middle parts of lateral outlines are slightly and somewhat irregularly arched, sometimes almost straight, and sometimes somewhat irregularly sinuated. Sculpture of surface somewhat variable. In the two specimens from Chubut, Puerto Madryn, the type-locality, it was of about the following type (Pl. II, fig. 3): Ventral and posterior main ridges very slightly developed; in one of these specimens the posterior was scarcely distinguishable. From a point somewhat in front of muscle-spots, a low ridge runs slantingly forwards and downwards, and from eye another low ridge runs in about the same direction. Surface covered with numerous, rather shallow, rounded to more or less irregular excavations; most of these rather small, some of moderate size. Bottoms of most of the larger excavations marked by a varying number, about two to five, of small pits. Arrangement of excavations variable; sometimes about as in the mentioned figure, sometimes irregularly scattered. In specimen from Isla Nueva, sculpture differed from type described above chiefly in the following respects (Pl. II, fig. 2): Ventral and posterior main ridges somewhat more developed, especially posterior part of ventral ridge and posterior ridge were well developed; they were one-sided, and their slopes towards margin of shell were very steep. Posterior ridge somewhat irregular, being sinuated dorsally. From point of union of these two ridges, a low, spur-like ridge continued out on beak-like postero-ventral process of shell. Excavations just posterior to middle of shell arranged in rather distinct longitudinal rows; excavations on dorsal half of shell perhaps on an average somewhat larger, and nearly all of them divided into small pits. Along anterior margin and along anterior part of ventral margin of shell, there is a series of about twenty-five to thirty flattened, hyaline, leaf-like hairs. No dark fields to be detected when shell is regarded by transmitted light.

First antenna: Of about same type as in *C. (C.) discophora.*

Second antenna (text fig. XIV, 2): Bristle on first endopodite joint somewhat shorter than in *C. (C.) montereyensis.* Distal half of second endopodite joint slightly broader, and its anterior wall somewhat stronger than in most species of this subgenus. *C. (C.) discophora* and *megalodiscus* agree in this respect with normal type of the subgenus. Positions of bristles of this joint nearly same as in *C. (C.) montereyensis.* Of the three bristles at about middle of posterior side, the postero-lateral is furnished with moderately strong pectination; the medial bristle about half as long as the postero-lateral, and of about same type as this but of subequal thickness throughout its entire length. Pilosity of protopodite about as in *C. (C.) discophora,* or the irregular longitudinal row of hairs on lateral side is more or less reduced. Spines on distal plates of second endopodite joint of moderate strength on lateral side and weak on medial side of the joint. There are no spines at base of anterior end claw.



Text fig. XIV. *Cythereis (Cythereis) mesodiscus,* n. sp., ♂, not type.
1. Right valve from the side. ×55.
2. Endopodite of right second antenna from the medial side. ×355. Tierra del Fuego, Isla Nueva.

Mandible: Masticatory joint and row of hairs on medial side of second endopodite joint about as in *C. (C.) discophora.* Peg-like appendage of epipodite seems to be naked or almost so. In other respects this appendage agrees with normal type.

Maxilla, fifth, sixth, seventh limbs, chitinous support of the three last-mentioned limbs, and brush-shaped organ, about as in *C. (C.) discophora*, ♂.

Penis (Pl. IV, fig. 7): No spiral thickening was detected in wall of vas deferens. Ductus ejaculatorius has no narrow, tube-like, free distal part but ends with a movable discus-like plate, somewhat larger than in *C. (C.) discophora*. Copulatory appendage well rounded distally and of moderate size.

Female: Unknown—

Remarks: The sculpture of the surface of the shell in the specimen taken at Isla Nueva showed, as is noted above, rather remarkable differences from that of the specimens from Chubut, Puerto Madryn. Do these differences indicate that the species in its present scope is not a natural systematic unit? This question can, of course, not be settled at present. The fact that all my specimens showed perfect agreement in other characters, and the differences in the sculpture exhibited by the two specimens from Chubut, the type-locality, seem, however, to indicate that this question is to be answered in the negative. It is undoubtedly most convenient to consider these three specimens tentatively as members of the same species.

All recorded specimens were closely examined.

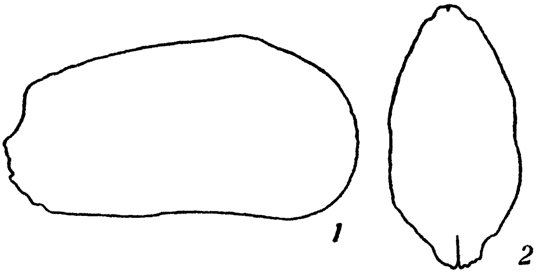
Habitat: **Tierra del Fuego**—Chubut, Puerto Madryn (type-locality); 8.XI.1895; depth, about 9 m.; sand: Two mature males (S.M.E.). **Isla Nueva**; 7.II.1896; depth, about 15 m.: One mature male (S.M.E.).

C. (Cythereis) megalodiscus, new species

Plate II, fig. 4; Plate IV, fig. 8; text fig. XV.

Description: Male—

Shell: Length, about 0.76 to 0.80 mm.; length: height, about 1.9-2.0:1; length: breadth, about 2.0-2.1:1. Seen from the side: Left valve (Pl. II, fig. 4): Of about same shape as in *C. (C.) mesodiscus*. Ventral part of anterior margin and anterior part of ventral margin more or less distinctly crenulated. Posterior margin somewhat steeper than in the mentioned species; along its ventral part and along posterior part of ventral margin, there are about five to nine more or less strong teeth. Dorsal margin somewhat sinuated just behind eye and just in front of posterior hinge-tooth. Ventral margin almost straight. Right valve (text fig. XV, 1): Differs from the left mainly in the following respects: Dorsal part of anterior margin slightly more flattened; dorsal part of posterior margin distinctly sinuated, not always as much, however, as in text fig. XV, 1. Dorsal margin without or with but slight sinuations anteriorly and posteriorly. Ventral margin in most cases slightly sinuated in front of middle. Seen from above (text fig. XV, 2, ♀): Somewhat irregular and not quite constant in shape; outline usually slightly sinuated in middle, tapering gently in front, and usually somewhat more abruptly behind; extremities somewhat irregular. Sculpture of surface (Pl. II, fig. 4): Seems to be rather constant; details of reticulation, of course, somewhat variable. Ventral main ridge one-sided and in most specimens fairly well developed along greater part of ventral margin. Posterior main ridge seems, in most cases, not to be developed. Along posterior part of dorsal margin, there is usually a low to moderately high, one-sided ridge. A narrow and rather low ridge runs somewhat inside and nearly parallel to anterior margin. Surface covered with a net-work of low, narrow ridges; meshes of this network of moderate size and usually irregular in shape; bottom of each mesh marked by a number of small, closely-set pits. Along anterior margin and along anterior half of ventral margin of shell, there are about twenty-five to thirty-five somewhat flattened, hyaline bristles; along posterior



Text fig. XV. *Cythereis (Cythereis) megalodiscus*, n. sp., not type.
1. Right shell from the side, ♂. ×60.
2. Shell from above; anterior end above, ♀. ×41. S. A. E., station 28.

part of ventral margin and along posterior margin there is a number of bristles, most of which are narrow. No dark fields to be detected when shell is regarded by transmitted light.

First antenna: Fourth joint somewhat more elongated than in *C. (C) montereyensis,* being about $\frac{8}{7}$, according to scale used in description of the subgenus. Bristle in front of the proximal claw of this joint sometimes about as long as in the mentioned species, sometimes distinctly shorter, even but half as long as claw. On first joint there is a longitudinal row of hairs both on medial and on distal side; hairs on anterior side of second joint somewhat scarcer than in *C. (C.) montereyensis;* pilosity of the two distal joints is also somewhat less developed than in most species of this subgenus. Finally, it should be noted that claws of fourth joint in most specimens are slightly longer relatively than in most species of this subgenus, being slightly longer than posterior side of second joint.

Second antenna: Exopodite distinctly three-jointed. Endopodite: Second joint: Positions of bristles about same as in Plate XXXV, fig. 19, G. W. Müller, 1894. Of the three bristles at about middle of posterior side of joint, the postero-lateral and the medial are subequal and approximately of same type, rather finely pectinated, their tips reaching to or slightly beyond point of attachment of the strong postero-distal bristle of this joint; the antero-lateral of these three bristles, i.e., the sensorial bristle, has about same type as in text fig. XVI, 3 of *C. (C.) ephippiata,* and is about one-third to one-half shorter than its neighbors. End joint: End claw perhaps slightly longer than in *C. (C.) montereyensis.* Of the two posterior (proximal) claws, the medial one has about same type and relative size as in most of the other species of this subgenus; the lateral distinctly shorter and weaker (about one-third shorter than the medial). Pilosity: On lateral side of protopodite there are usually scattered, exceedingly short and fine hairs; on medial side of this joint a longitudinal row of fine hairs occurs. Along postero-distal edge of second endopodite joint, there are very short and fine hairs. Spines of distal plates of this joint apparently weak; however, I have not been able to establish this character with full certainty.

Mandible: Masticatory joint: Toothed edge of pars incisiva has about same type as in *C. (C.) montereyensis*. No hump on dorsal part of this joint. The two short ventro-distal bristles of first endopodite joint usually somewhat shorter than in most of the species of this subgenus. Longitudinal row of hairs on medial side of second endopodite joint generally composed of rather short hairs.

Maxilla: Of about same type as in *C. (C.) discophora*.

Fifth limb: Exopodite slightly longer, when compared with protopodite, than in *C. (C.) montereyensis;* furthermore, it is somewhat more slender than in this species. Bristle on posterior side of protopodite swollen at base and furnished with long, soft hairs. [In *C. (C.) discophora* and *mesodiscus* these hairs are somewhat longer than in most of the species of this subgenus, but stiff. Moreover, this bristle is not swollen at the base in these two species.] Bristle of first exopodite joint somewhat weaker and end claw perhaps slightly weaker and longer than in *C. (C.) montereyensis;* end claw nearly naked.

Sixth limb: Exopodite somewhat longer, when compared with protopodite, than in *C. (C.) montereyensis;* differences, however, not great, as will be seen from the following figures:

Protopodite $\frac{10}{13}$ Exopodite I. $\frac{7}{9.5}$ II. $\frac{7.5}{6}$ III. $\frac{7}{6.5}$

It is also slightly more slender than in this species. End claw, which is nearly naked, also slightly longer relatively and somewhat more slender than in text fig. VIII, 15 of *C. (C.) montereyensis*. In other respects this limb agrees with that of male of the mentioned species.

Seventh limb: Of about same type as sixth limb. Relative lengths of joints:

Protopodite $\frac{11}{14.5}$ Exopodite I. $\frac{10.5-11.0}{13}$ II. $\frac{8}{6.5}$ III. $\frac{8}{8}$

The proximal of the three bristles on anterior side of protopodite about as well developed as in *C. (C.) discophora*. Other bristles of this joint sometimes slightly shorter relatively than in *C. (C.) montereyensis*. Exopodite: Bristle of first joint about as long as second joint and almost as thin as corresponding bristle of sixth limb of male; contrary to the last-mentioned bristle, it is, however, in most cases furnished with a coat of dense, short, and fine hairs. End claw has about same type and relative length as in sixth limb, its pectination, however, somewhat better developed.

Some of the dorsal strips of chitinous support of these limbs, on the sides of body, appear to be absent in most specimens.

Brush-shaped organ: Of about same type as in *C. (C.) montereyensis.*

Penis (Pl. IV, fig. 8): Of about same type as in *C. (C.) mesodiscus;* differences between penes of *C. (C.) mesodiscus* and *megalodiscus,* however, greater than between penes of *C. (C.) discophora* and *mesodiscus* (compare accompanying figures). Especially noteworthy is difference in size of discus-shaped plate of ductus ejaculatorius; this plate distinctly larger in *C. (C.) megalodiscus* than in *C. (C.) mesodiscus,* a character for which the species has been named. No spiral thickening could be detected in wall of vas deferens. Ductus ejaculatorius has no free distal part.

Description: Female—

Shell: Length, about 0.79-0.88 mm.; length: height, about 1.7-1.8:1; length: breadth, about 1.83-1.93:1. Of about same shape and structure as in male, but distinctly higher and broader relatively, as will be seen from figures given above.

Second antenna: Differs from that of male mainly in the following respects: Exopodite as in *C. (C) montereyensis,* ♀. Of the three bristles at about middle of posterior side of second endopodite joint, the postero-lateral and the medial are, on an average, slightly longer relatively. The two posterior, proximal, claws of end joint are of about normal size and strength; or the lateral is but slightly weaker and shorter. Spines on distal plates of second endopodite joint weak.

Fifth limb: Almost perfectly of same type as in *C. (C.) montereyensis,* ♀, perhaps slightly longer and weaker. End claw almost naked and slightly longer and weaker relatively than in the mentioned species.

Sixth limb: Either of about same type as in *C. (C.) montereyensis,* or exopodite slightly longer, when compared with protopodite, and slightly more slender. Bristle on posterior side of protopodite has about same type as that of fifth limb. End claw resembles that of male; frequently it is somewhat less curved than in *C. (C.) montereyensis;* this seems also to be true of end claws of fifth and seventh limbs, both in males and females. Bristle on first exopodite joint about half as long as second joint or slightly longer or shorter; in some cases this bristle is slightly weaker than in the mentioned species. Other bristles of this limb about as in *C. (C.) montereyensis*, ♀.

Seventh limb: Of about same type as in male.

Genital verruca and hind part of body about as in *C. (C.) montereyensis*. Bristle on posterior extremity of body, however, situated on a verruciform projection of about same shape as in plate 18, figure 11 *(Paracytheroma pedrensis)*, Ch. Juday, 1907. No spines were detected in the neighborhood of this bristle.

Remark: Four mature males and three mature females were examined.

Habitat: **South Georgia**—S.A.E., Station 25, off **Grytviken**, lat. 54° 22′ S., long. 36° 27′ W.; 21.V.1902; depth, 24 to 52 m.; grey clay with scattered algæ: Two mature males, seven mature females, and four juvenes. S.A.E., Station 28, off **Grytviken**, lat. 54° 22′ N., long. 36° 28′ W. (type-locality); 24.V.1902; depth, 12 to 15 m.; sand and algæ: Eighteen specimens, mature males and females, and juvenes. S.A.E. (no number of the station), **Grytviken**; 24.V.1902; depth, 1 to 2m.: One mature male, dead when taken.

Frequens Group nov.

Only one of the species described in this paper, viz., *C. (C.) frequens*, belongs to this group. Among the other species of this genus, *C. (C.) devexa* G. W. Müller, 1908, is to be assigned to this group. Another probable member is *C. wyvillethomsoni* (G. S. Brady, 1880).

C. (Cythereis) frequens new species

Plate II, fig. 5; Plate V, fig. 1.

Description: Male—

Shell: Length, 0.95 to 1.02 mm.; length: height, about 1.9 to 2:05:1; length: breadth, about 2.1 to 2.2:1. Seen from the side: Left valve: Of about same shape as in *C. (C.) megalo-*

discus. Following features are noteworthy: Anterior margin fringed with a regular series of small teeth. Sinuation of dorsal margin just in front of posterior hinge-tooth very slight, sometimes not even distinguishable. Dorsal part of posterior margin nearly straight to very slightly sinuated. Ventral margin slightly sinuated in front of middle and slightly convex behind middle. Along posterior part of ventral margin and along ventral part of posterior margin, there are six to nine rather strong teeth. Right valve: Differs from the left mainly in the following respects: Hump just above eye very slightly, or not at all, developed; dorsal part of posterior margin somewhat more sinuated. Seen from below: Somewhat irregular in shape. Side contours usually somewhat sinuated at about middle; converge gently towards the rather narrow, irregularly truncated anterior extremity; sub-parallel just behind middle; and converge abruptly towards the irregularly truncated posterior extremity. (See *C. devexa*, G. W. Müller, 1908, Pl. XVII, fig. 8.) Sculpture of surface (Pl II, fig. 5; ♂ = ♀): Seems to be very constant; details of reticulation, of course, somewhat variable. Ventral ridge, which has a narrow edge, well developed along entire ventral margin. Along anterior part of posterior half of dorsal margin of shell, there is a more or less well developed, one-sided ridge, which does not cover dorsal margin, when shell is regarded from the side. Posterior main ridge very short and of about same type as postero-dorsal ridge with which it forms a sub-rectangular, fairly sharp to somewhat rounded corner. Just inside, and subparallel to, posterior margin, there is a rather low and narrow ridge. Along anterior margin of shell, often covering it when shell is regarded from the side, there is a narrow, more or less well developed, usually rather low ridge. Surface of shell characterized by closely-set angular excavations of moderate size and depth; those just outside muscle-spots somewhat smaller than the others. Ridges separating these excavations of subuniform height and breadth, narrow. Sometimes excavations are rather shallow; their bottoms fairly smooth. Along anterior margin and along anterior part of ventral margin of shell, about twenty-five to thirty-five narrow to but slightly flattened, simple bristles of moderate length occur; along posterior half of ventral margin of shell such bristles are also found. No dark fields to be detected, when shell is regarded by transmitted light.

First antenna: Relatively elongated. Relative lengths of joints about as follows:

I. $\frac{14}{16}$ II. $\frac{13}{10}$ III. $\frac{4}{5}$ IV. $\frac{11}{10}$ V. $\frac{4}{5}$

Bristle on second joint distinctly longer than posterior side of this joint; its point reaches to about distal boundary of fourth joint. Relative lengths of bristles about same as in text fig. VI, 5 of *C. (C.) montereyensis.* Claws of fourth joint distinctly longer than posterior side of second joint. Length of bristle just in front of proximal claw of fourth joint rather variable, sometimes only about one-half as long as claw. Pilosity: On first joint there is a longitudinal row of hairs on both medial and on lateral sides. Hairs on anterior side of second joint somewhat less numerous than in *C. (C.) montereyensis.* Hairs on fourth joint perhaps somewhat weaker than usual.

Second antenna: Of about same type as in *C. (C.) longiductus,* ♂. Bristle of first endopodite joint almost as long as posterior side of second endopodite joint. The sensorial, antero-lateral, of the three bristles at about middle of posterior side of second endopodite joint about as in *C. (C.) montereyensis,* ♀. Spines of distal plates of second endopodite joint have about same strength on both sides of joint, rather weak to moderately strong.

Mandible: Masticatory joint: The next to the anterior tooth of pars incisiva paired; the next to the posterior pair of teeth distinctly larger than in *C. (C.) montereyensis,* and posterior pair of teeth not so deeply bifurcated as in this species. Dorsal half of this joint has no, or only a very small, hump on its anterior side. Palp slightly more slender, and its distal joint slightly longer than in most species of this subgenus. Of the eight dorso-distal bristles of second endopodite joint, the long, annulated one (i.e., the one situated just ventrally to verruciform process on which the seven others are situated) is relatively weak, of about same strength as the five long ones, and only rather slightly longer than end joint. Due to elongation of end joint, the long bristles of this joint are not quite twice as long as joint. Hairs in the row of hairs on medial side of second endopodite joint sometimes as short as in *C. (C.) montereyensis,* sometimes slightly longer.

Maxilla: Among the dorso-distal bristles of first joint of palp, the long one and one of the short sometimes are furnished with hairs of moderate length, sometimes they have short hairs.

Fifth limb: Exopodite somewhat longer, when compared with protopodite, and somewhat more slender than in *C. (C.) montereyensis.* Bristles of protopodite have about same types as in male of this species but are, as a rule, slightly longer relatively. Bristle on first exopodite joint has about same type as in *C. (C.) montereyensis.* End claw slightly longer than in this species and almost naked.

Sixth limb: Exopodite somewhat longer, when compared with protopodite, and somewhat more slender than in *C. (C.) montereyensis;* first exopodite joint somewhat longer than second exopodite joint. Bristles of protopodite about as in *C. (C.) montereyensis.* Bristle on first exopodite joint, which is about as strong as in *C. (C.) montereyensis,* ♀, or but slightly weaker, is about half as long as second exopodite joint, or slightly longer. End claw somewhat longer and weaker than in the mentioned species and of about same type and size as that of fifth limb.

Seventh limb: Just as in the two preceding limbs, exopodite is somewhat longer, when compared with protopodite, and somewhat more slender than in *C. (C.) montereyensis;* first exopodite joint is somewhat, in most cases rather considerably, longer than second exopodite joint. Among the three bristles on anterior side of protopodite, the proximal is somewhat better developed than in *C. (C.) montereyensis,* but still it is nearly vestigial; the two remaining ones are about as in this species. Bristle on first exopodite joint usually slightly weaker than in *C. (C.) montereyensis,* and in most specimens about as long as second exopodite joint. End claw is similar to that of sixth limb but slightly longer and furnished with rather weak pectination.

Chitinous support of these three limbs, on sides of body, has about same type as in most of the species of this subgenus but usually somewhat simpler, one to a few bars being absent or more or less weak and irregular.

Brush-shaped organ: About intermediate in shape and structure between that of *C. (C.) montereyensis* and that of *C. (C.) platycopa.*

Penis (Pl. V, fig. 1): Recalls strikingly this organ in *Cythereis devexa,* G. W. Müller, 1908, p. 137, fig. 1; as to differences, compare figures. Vas deferens has distally a spiral thickening. Ductus ejaculatorius ends in a large, peculiar, and very complicated appendage which is nearly as large as copulatory appendage (when regarded from within even somewhat more complicated than in accompanying figure). Right and left penes of about same type.

Furca: Seems to have only two bristles; the short and narrow bristle of the other species appears to be absent.

Description: Female—

Shell (Pl. II, fig. 5): Length, 0.95 to 1.03 mm.; length: height, about 1.8 to 1.9:1; length: breadth, about 1.9 to 2.0:1. Seen from the side as well as from below, of about same shape as in male but somewhat higher and wider relatively. Also in other features shells agree in the two sexes.

Second antenna: Of about same type as in *C. (C.) longiductus,* ♀.

Fifth limb: Of about same type as in male, but bristle on posterior side of protopodite similar to corresponding bristle in *C. (C.) montereyensis,* ♀.

Sixth limb: Of about same type as in male. Bristle on the posterior side of protopodite, however, of same type and size as corresponding bristle of fifth limb.

Seventh limb: Of about same type as in male.

Genital verruca and posterior part of body about as in *C. (C.) montereyensis.* End bristle of body situated on a verruciform process. No spines were detected on back of posterior part of body.

Remarks: This species appears to be structurally rather close to *Cythereis devexa,* described by G. W. Müller, 1908, p. 137, from the Antarctis, the "Gauss-station". Differences between the two species are to be found both in the shape and sculpture of the shell and in the structure of the penis. (The other organs are unknown in *C. devexa.*) The differences are, however, apparently fairly small.

It is probably also fairly closely related to *C. wyville-thomsoni*, G. S. Brady, 1880, Pl. XX, fig. 4. Only the shell is known of this species.

Among the specimens examined by me, some had the same size of shell and the same structure of appendages as the mature ones but their external genitalia were very slightly developed.

Four mature males and five mature females were examined.

Habitat: **South Georgia**—S.A.E., Station 25, off **Grytviken**, lat. 54° 22′ S., long. 36° 27′ W.; 21.V.1902; depth, 24 to 52 m.; grey clay with scattered algæ: 111 specimens: 21 mature males; 34 juvenes (smaller than the mature specimens); the rest were either mature females or specimens of the type noted in the section of "remarks".

Ephippiata Group nov.

This group comprises, among the species described in this paper, *C. (C.) ephippiata, théeli,* and *recurvirostra.*

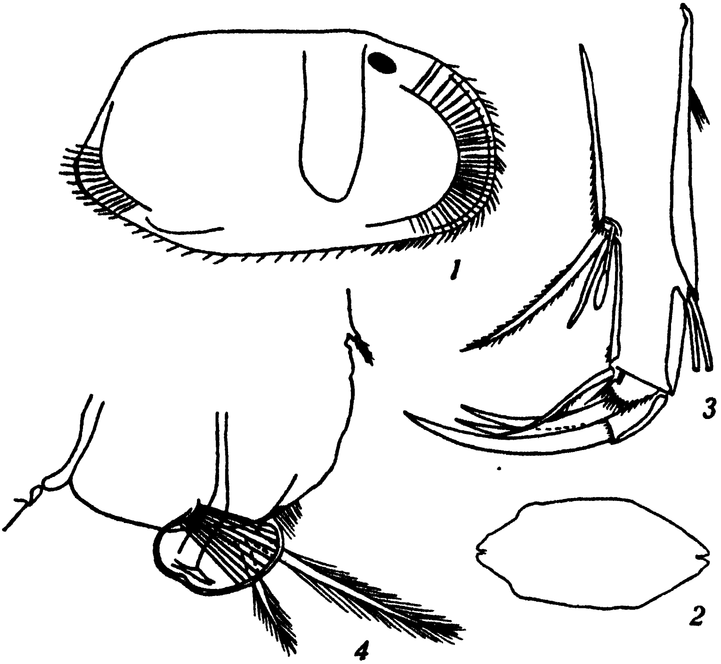
C. (Cythereis) ephippiata, new species

Plate II, fig. 7; Plate III, fig. 3; Plate V, fig. 2; text fig. XVI.
Cythereis sp. . . . . T. Skogsberg, 1920, p. 145.

Description: Male—

Shell: Length, about 0.77 to 0.81 mm.; length: height, about 1.85 to 1.90:1. Seen from the side: Left valve: Rather elongated, highest somewhat behind middle, dorsal and ventral margins sub-parallel to each other. Dorsal margin slightly convex to nearly straight. Anterior and posterior parts of ventral margin almost straight, or the anterior is slightly sinuated; they form together a broadly rounded, more or less distinct corner somewhat behind middle of valve. Anterior margin lacks distinct crenulation. Posterior extremity of valve produced somewhat below middle in a distinct, subrectangular, rounded, beak-like projection; margin of this beak has no distinct serrulation or spines; dorsal part of posterior margin of valve straight, or almost so, and forms with dorsal margin a broadly rounded corner; ventral part of posterior margin passes into ventral margin without forming any distinct corner. Right valve (text fig. XVI, 1) almost perfectly of same shape as left one. Seen from below (text fig. XVI, 2), shell is about twice as long as wide, with subparallel sides in middle, its anterior extremity sub-acuminate, its posterior sub-mucronate. Sculpture of surface: Surface covered with closely-set, angular excavations of moderate size and depth (in a few specimens rather shallow), and of somewhat varying shapes; in posterior part of shell, excavations are arranged in more or less distinct rows, sub-parallel to longitudinal axis of shell (Pl. II, fig. 7; ♂ = ♀). Bottom of each excavation has about two to six small pits, bordered by ridges somewhat narrower and lower than those surrounding the large excavations (Pl. III, fig. 3). At muscle-spots surface sometimes is slightly elevated and nearly smooth. Of the main ridges, only the ventral is developed; this is represented, along greater part of ventral margin of shell, by a low ridge (in a few specimens somewhat higher than in the figure of female shell), and ends near posterior end of shell in a short, but usually rather prominent, wing-like, and rounded projection. Pores of surface often rather difficult to detect. Among bristles along anterior margin and along anterior part of ventral margin of shell, about thirty to forty are of moderate length, simple, and slightly widened and flattened; at least some of these bristles have very short, fine marginal hairs. Remaining bristles along margin of shell rather short, simple, and narrow. When seen by transmitted light, shells of specimens preserved in alcohol have a brownish color. Just behind eye, there is a rather broad, dark, saddle-shaped band (about as in text fig. XVI, 1), a character which makes the species very easy to recognize and from which it has been named. By reflected light shell has a slight pink tint, and saddle is milky white, when body is within shell (preserved specimens). When dried and seen by reflected light, shell is milky white, without any visible saddle. Saddle evidently caused by heavy incrustation of lime.

First antenna: Fourth joint somewhat more elongated than in *C. (C.) montereyensis*, being about $\frac{9}{8}$, according to scale used in description of subgenus. The long claws are in some cases somewhat, though very slightly, longer relatively; and the two distal ones of them are somewhat weaker distally than in text fig. VI, 5 of the mentioned species. On lateral



Text fig. XVI. *Cythereis* (*Cythereis*) *ephippiata*, n. sp., not type.
1. Right valve from the side, ♂. ×70.
2. Shell from below; anterior end to the right, ♀. ×31.
3. Second and third endopodite joints of right second antenna, seen from lateral side, ♂. ×355.
4. Posterior part of female body seen from the left. ×355. S. A. E., station 46.

side of first joint, there are a number of scattered, short hairs. On medial side a rather short, irregular row of short hairs (almost scattered) occurs. Long hairs and pectination on anterior side of second joint are somewhat reduced.

Second antenna (text fig. XVI, 3): Slightly more slender than usual. Exopodite: Somewhat more elongated than usual and rather distinctly three-jointed. Endopodite: Bristle of first joint somewhat shorter than in *C. (C.) montereyensis*. Second joint: Positions of bristles about same as in Pl. XXXV, fig. 19, G. W. Müller, 1894. Of the three bristles at about middle of posterior side, the postero-lateral is furnished with a moderately strong pectination; the antero-lateral characterized by unusually distinct shaft and head; the medial rather narrow, of subequal width throughout its entire length, naked or almost so, and about half as long as the postero-lateral bristle of this group. The strong postero-distal bristle of this joint relatively weak and almost naked. Distal joint: Claws relatively long, end claw being about four to five times longer than anterior side of joint. Pilosity: On medial side of protopodite, there is a relatively long longitudinal row of fine and rather short hairs, as well as a number of scattered hairs; on lateral side of this joint, there are rather numerous more or less scattered hairs of moderate length and some hairs arranged in an irregular, longitudinal row. Spines on distal plates of second endopodite joint, perhaps, somewhat stronger than in *C. (C.) montereyensis.*

Mandible: Masticatory joint: The next to the anterior tooth of pars incisiva, which is single in text fig. VII, 9 of *C. (C.) montereyensis*, is paired. The next to the posterior pair of teeth somewhat larger relatively than in the mentioned species. There is a rounded hump on anterior side of dorsal half of this joint. Second endopodite joint: The long, annulated dorso-distal bristle, i.e., the bristle which is not attached to verruciform process, somewhat weaker and shorter relatively than in text fig. VII, 9 of *C. (C.) montereyensis*, being about, or not quite, twice as long as end joint. Sometimes the annulated, dorsal, bristle of distal joint is also a little shorter relatively than in *C. (C.) montereyensis.* Row of hairs on medial side of second endopodite joint usually consists of hairs somewhat longer than in figure mentioned above.

Maxilla: The long one of the four dorso-distal bristles of first joint of palp has hairs of moderate length.

Fifth limb: Exopodite slightly longer, when compared with protopodite, than in *C. (C.) montereyensis;* first exopodite joint slightly longer than second and third exopodite joints, which are subequal. Bristle on posterior side of protopodite about as long as, or somewhat longer than, distal joint and of about same type as in *C. (C.) montereyensis*, ♂ ; its hairs are, however, somewhat longer. Bristle on first exopodite joint somewhat weaker than in the mentioned species. End claw, which is almost naked, somewhat longer relatively, and perhaps slightly weaker than, in *C. (C.) montereyensis.*

Sixth limb: Joints of about same relative lengths, and with about same relative lengths and types of bristles as in *C. (C.) glauca*, ♂. Posterior bristle of protopodite has hairs somewhat longer than in most species of this subgenus. End claw somewhat longer than in *C. (C.) montereyensis*, with very fine pectination. On outside of protopodite, somewhat distally to posterior bristle, there is a group of fairly long hairs.

Seventh limb: Of about same shape as in *C. (C.) montereyensis*; exopodite, however, somewhat more elongated than in this species. Bristles of protopodite, too, approximately as in this species; the two distal of the three bristles on anterior side of this joint, however, usually slightly shorter relatively. Bristle on first exopodite joint narrow (it resembles corresponding bristle of sixth limb in male) and about as long as second exopodite joint, or somewhat shorter. End claw somewhat longer than in *C. (C.) montereyensis*. On outside of protopodite, somewhat distally to posterior bristle, there is a group of fairly long hairs.

Chitinous support of these three limbs, on sides of posterior part of body, usually somewhat stronger and of a somewhat simpler type than in *C. (C.) montereyensis*.

Brush-shaped organ: About intermediate between that of *C. (C.) montereyensis* and that of *C. (C.) platycopa*.

Penis (Pl. V, fig. 2): Right and left organs of same type. No spiral thickening detected in walls of vas deferens. Free tube of ductus ejaculatorius of moderate length; its point, which does not extend to point of copulatory appendage, furnished with a rather characteristic spine. Copulatory appendage rather short and pointed.

Description: Female—

Shell (Pl. II, fig. 7 and text fig. XVI, 2): Length, about 0.76 to 0.80 mm.; length: height, about 1.75 to 1.80:1. Of about same type as in male but somewhat higher relatively; usually posterior part somewhat lower, when compared with anterior part, than in males.

Second antenna: Exopodite: Relatively short, being only about one and one-half times longer than anterior side of first endopodite joint, or slightly longer; its proximal joint, which is not much wider than distal joint, not widened distally; proximal joint shows slight signs of articulation at about middle. Endopodite: Of the three bristles at about middle of posterior side of second joint, the postero-lateral and the medial are furnished with moderately strong pectination. Just as in male, claws of distal joint are almost naked.

Fifth limb: Bristle on posterior side of protopodite swollen at base and has long hairs proximally and short hairs distally. Bristle on first exopodite joint, which is about half as long as second exopodite joint, or slightly longer, has about same strength as in *C. (C.) montereyensis.*

Sixth limb: Differs from that of male mainly in the following respects: Bristle on posterior side of protopodite has about same type as corresponding bristle of fifth limb in female. Bristle on first exopodite joint of about same type and relative length as in *C. (C.) montereyensis,* ♀.

Seventh limb: Of about same type as in male; bristle of first exopodite joint, however, of about same type and relative length as in *C. (C.) montereyensis.*

As to genital verruca, furca, and posterior part of body, see text fig. XVI, 4. I have not been able to detect any rows of spines on posterior part of body. The verruca on which terminal bristle of body is situated is less developed than in most species of this genus.

Remarks: This species is identical with the form discussed on page 145 of my work of 1920 under the name of *Cythereis sp.* At this place the length of the male shell is erroneously stated to be 0.80 to 0.83 mm., instead of 0.77 to 0.81 mm. The lengths of the larval stages are, however, correct. This makes, of course, the agreement with Brooks's law still more striking.

The outlines of the larval shells show the peculiarities noted by G. W. Müller, 1894, p. 181. The surface of the shell in the two youngest stages is covered with closely-set, small, rounded pits, which are not arranged in distinct groups or "excavations," according to the terminology used in the description given above. In the first larval stage, the sculpture exhibits a type transitional between that of the second larval stage and that of the mature specimen; some of the walls between the pits are somewhat higher than others. (Is this an illustration of the phylogenetic development of the sculpture? Cf. G. W. Müller, 1894, p. 88.) The saddle-shaped structure is to be found in the first, and usually also in the second, larval stage; not, however, in the third larval stage.

Two males and two females, as well as the shells of the remaining specimens, were examined.

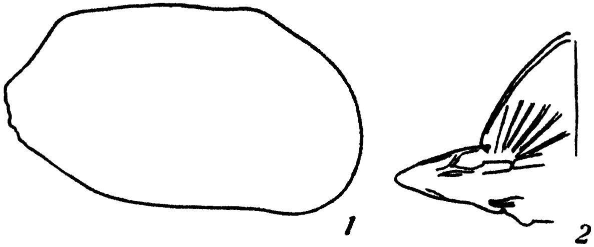
Habitat: **Falkland Islands**—S.A.E., Station 41, **Berkeley Straits, Port Louis,** lat. 51° 33′ S., long. 58° 9′ W.; 23.VII. 1902; depth, 2 to 4 m.; clay and sand: One female. S.A.E., Station 46, **Carenage Creek, Port Louis,** lat. 51° 32′ S., long. 58° 7′ W.; 9.VIII.1902; depth, 1 m.; sand with great quantities of *Codium:* Fourteen mature specimens, males and females, and some larvæ (two specimens and one valve of the first larval stage, four specimens and three valves of the second larval stage, and five specimens and two valves of the third larval stage).

C. (Cythereis) théeli, new species

Plate II, fig. 6; Plate V, fig. 3; text fig. XVII.

Description: Male—

Shell (Pl. II, fig. 6): Length, about 0.77 to 0.78 mm.; length: height, about 1.7:1; length: breadth, about 1.95:1. Seen from the side: Left valve: Of about same shape as in *C. (C.) ephippiata,* ♀, but dorsal margin slopes somewhat more posteriorly, and posterior corner of valve situated somewhat more dorsally and is somewhat more broadly rounded. Dorsal part of posterior margin of valve gently convex. Ventral part of anterior margin and anterior part of ventral margin of valve very finely crenulated; and on posterior process of valve there are four rather strong teeth. Right valve (text fig. XVII, 1) resembles corresponding valve in *C. (C.) ephippiata,* ♀; dorsal margin slopes, however, somewhat more posteriorly; serrulation and teeth as in left valve. Seen from above, the shell has about same shape as in *C. (C.) montereyensis.* Sculpture of surface appears to be quite constant. Main ventral ridge one-sided and well developed along entire ventral margin of shell. Just inside and about parallel to anterior margin of shell, there is a low, narrow ridge. A similar ridge extends from eye along anterior part of dorsal margin of shell. From about middle of anterior margin of shell, a rather low, narrow, and smooth ridge runs to the anterior of muscle-spots. Surface of shell is covered with angular to more or less rounded excavations of moderate depth; generally speaking, excavations near the margin of shell are rather small, the others are of moderate size. Excavations along edge of ventral main ridge rather small and arranged in a distinct row; most of the others scattered fairly irregularly, some of those on posterior half of shell, however, arranged in groups, forming more or less distinct longitudinal rows. In some specimens the ribs between these longitudinal rows are somewhat more prominent than in Pl. II, fig. 6. Hairs along margin of shell resemble those of *C. (C.) ephippiata.* No dark fields to be detected when shell is regarded by transmitted light (of course, with the exception of ridges).



Text fig. XVII. *Cythereis (Cythereis) théeli*, n. sp., ♂, not type.
1. Right valve from the side. ×61.
2. Part of left penis, seen from lateral side. ×73. Tierra del Fuego, Chubut.

First antenna: Of about same type as in *C. (C.) ephippiata;* the short, latero-distal spine of fourth joint somewhat smaller than usual.

Second antenna: Of about same type as in *C. (C.) ephippiata.* Shaft of the lateral, sensorial, one of the three bristles at about middle of posterior side of second endopodite joint somewhat shorter, when compared with distal part, than in text fig. XVI, 3 of this species. [This character, however, somewhat variable in *C. (C.) ephippiata.*] Bristle of first endopodite joint somewhat weaker than in most species of this subgenus, and its tip reaches but a short distance beyond point of attachment of the three bristles noted above.

Mandible: Resembles that of C. *(C.) ephippiata;* the two short ones of the four ventro-distal bristles of first endopodite joint somewhat shorter than in C. *(C.) montereyensis.*

Maxilla, fifth and sixth limbs about as in C. *(C.) ephippiata.*

Seventh limb: Differs from that of the mentioned species in having end claw somewhat shorter, about as long as in C. *(C.) montereyensis.*

Chitinous support of these limbs, on sides of body, and brush-shaped organ as in C. *(C.) ephippiata.*

Penis (Pl. V, fig. 3 and text fig. XVII, 2): Of about same type as in the mentioned species. The most important difference to be found in copulatory appendage; this is somewhat longer and lower in the present species; appendage of right penis somewhat more pointed than that of left.

Remarks: This species is structurally very close to, perhaps not even specifically different from, *Cythere impluta,* G. S. Brady, 1880, Pl. XXVI, fig. 6. On the other hand, it is certainly not identical with *C. impluta,* G. S. Brady, 1880, Pl. XVI, fig. 3. Even G. S. Brady hesitated to unite these two forms. He wrote as follows on page 77 of the mentioned paper: "The somewhat different forms figured in Plates XVI and XXVI, I at first supposed to belong to distinct species, but my impression now is that they cannot properly be separated." If, however, G. S. Brady's (1880) figures are to be trusted at all, then these two forms cannot possibly belong to the same species. The name of *impluta* should be kept for the form represented by Pl. XVI, fig. 3.

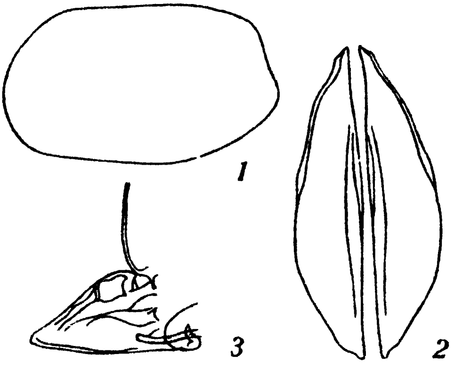
Habitat: **Tierra del Fuego, Chubut** (type-locality); 8.XI. 1895; depth, 9 m.; sand: Two mature males and one detached valve (S.M.E.).

C. (Cythereis) recurvirostra, new species

Plate IV, fig. 1; Plate V, fig. 4; text fig. XVIII.

Description: Male—

Shell (Pl. IV, fig. 1 and text fig. XVIII, 1): Length, about 0.95 mm.; length: height, about 1.8:1; length: breadth, about 2.1:1. Seen from the side: Left valve has about same shape as in C. *(C.) ephippiata,* ♀, but its edge lacks crenulation and teeth. Right valve: Also of about same shape as in the mentioned species, but postero-dorsal corner somewhat more distinct and ventral margin slightly sinuated in front of middle. Seen from below (text fig. XVIII, 2), shell has about same shape as in *C. (C.) théeli.* Sculpture of surface has about type described for *C. (C.) théeli.* The following features should be noted: There is a postero-dorsal ridge, just as in *C. (C.) frequens.* In specimen examined there was no row of excavations along ventral main ridge, and the small excavations, near margin of shell, were somewhat less distinct. Marginal bristles as in *C. (C.) ephippiata.* No dark fields to be detected when shell is regarded by transmitted light (of course, with the exception of ridges).



Text fig. XVIII. *Cythereis (Cythereis) recurvirostra*, n. sp., ♂, type.
1. Left valve from the side. ×38.
2. Shell from below; anterior end above. ×43.
3. Copulatory appendage of left penis from the lateral side. ×105. S. A. E., station 59.

First antenna: Of about same type as in *C. (C.) ephippiata.* On medial side of first joint, no longitudinal row of hairs seems to be present. On lateral side of this joint there is a very irregular longitudinal row of short hairs; hairs may, perhaps, better be described as scattered.

Second antenna: Of about same type as in *C. (C.) ephippiata.* Bristle of first endopodite joint is about as long as in *C. (C.) montereyensis.* Of the three bristles at about middle of posterior side of second endopodite joint, the antero-lateral, sensorial one is about as in *C. (C.) théeli.* Of the two proximal, posterior, end claws of distal joint, the lateral is about as long as the medial, but somewhat weaker.

Mandible, maxilla, fifth, sixth, and seventh limbs, chitinous support of the last three appendages, on sides of body, and brush-shaped organ, all resemble the corresponding organs in *C. (C.) ephippiata.*

Penis also about same as in *C. (C.) ephippiata.* As to differences between these two species in the shapes of copulatory appendages, compare Pl. V, fig. 4 and text fig. XVIII, 3 on the one hand with figures of this organ in the noted species on the other.

Habitat: S.A.E., Station 59, on the **Burdwood Bank,** lat. 53° 45′ S., long. 61° 10′ W.; 12.IX.1902; depth, 137 to 150 m.; mussel sand with stones: One mature male.

Glauca Group nov.

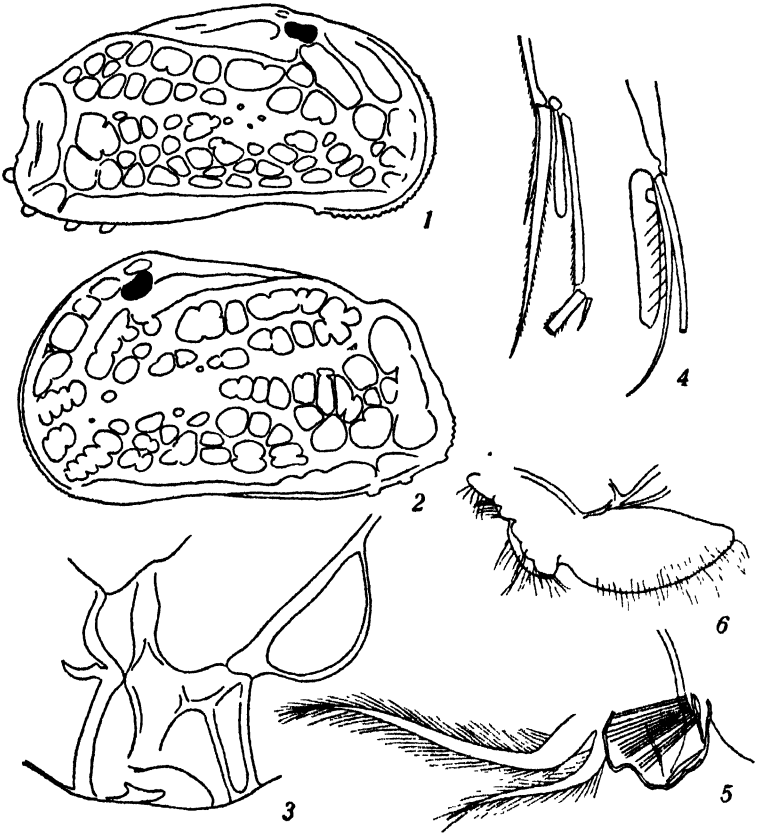
Out of the species described in the present paper, *C. (C.) glauca, platycopa,* and *aurita* presumably belong to this group. The assignments of these species to one group, however, is somewhat uncertain.

C. (Cythereis) glauca, new species

Plate III, figs. 2, 6 and 7; Plate VI, fig. 4; text fig. XIX.

Description: Male—

Shell: Length, 0.74 to 0.76 mm.; length: height, about 2:1; length: breadth, about 2.25:1. Seen from the side: Left valve: Oblong, highest in front of middle, at about anterior hinge-tooth, and with anterior half distinctly larger than posterior. Lower half of anterior margin and anterior part of ventral margin finely crenulated. Dorsal margin evenly and moderately convex, slopes gently posteriorly, and has a slight depression just behind greatest height of valve. Posterior extremity produced below middle in a sub-rectangular, broadly rounded beak; dorsal part of posterior margin, which is distinctly concave (Pl. III, fig. 2) or almost straight, forms with dorsal margin a broadly rounded, but very distinct, more or less gibbous corner. Ventral margin almost straight, slightly sinuated in front of middle, and joins posterior without forming any corner. On posterior beak-like process and just antero-ventrally to this, margin of valve furnished with a varying number (four to ten) of teeth, the shapes and sizes of which are rather variable. Right valve (text fig. XIX, 1): Differs from left one mainly in the following respects: Slightly smaller; anterior margin slightly depressed above eye; dorsal margin very slightly or not at all depressed behind greatest height of valve; ventral margin slightly more sinuated in front of middle. Seen from below and from above (Pl. III, figs. 6, 7 of female): Widest at about or somewhat behind middle. Side contours are somewhat irregular, in some specimens even somewhat more so than in the mentioned figures; converge gently towards front end and fairly abruptly behind; sometimes, when dorso-posterior ridge is relatively prominent, as in Pl. III, fig. 6, the posterior taper is even quite abrupt. Anterior extremity broadly pointed, posterior in most cases somewhat more rounded. Sculpture of surface rather constant; slight variations, however, found in the number, shape, size, and arrangement of depressions, as well as in the width and height of the ridges separating depressions; especially the last-mentioned variations alter the appearance of shell. Two valves may at first sight look quite different, but a close examination of structural details will show that the general type of sculpture is about the same. Just inside and about parallel to margin of shell, there is a rather broad, low, and rounded ridge, which runs along entire anterior margin and extends along a longer or shorter part of dorsal margin (Pl. III, fig. 6, shell seen from above). A similar, somewhat narrower, ridge runs from near eye steeply and slantingly forwards and downwards, joining the anterior ridge at about half the height of shell. Ventral ridge one-sided, its ventral slope more or less concave; usually well developed along entire ventral margin of shell, ending posteriorly in one or two narrow spurs, on postero-ventral beak of shell. From a point somewhat below and posterior to eye, a rather strong ridge runs slantingly upwards and backwards, forming, in most specimens, a rather regular curve; when shell is seen from the side, this ridge, which has a very steep dorsal slope, covers a rather great part of the posterior half of dorsal margin of



Text fig. XIX. *Cythereis* (*Cythereis*) *glauca*, n. sp., not type.

1. Right valve from the side, ♂. ×76.
2. Left valve from the side, ♀. ×83.
3. Chitinous support of proximal part of left second antenna and of the joint-like process onto which this is attached; seen from lateral side. The heavy strip to the left with a short branch near the middle belongs to the antenna; the rest to the joint-like process. ♂. ×410.
4. Distal part of second endopodite joint of right second antenna seen from lateral side, ♂. ×405.
5. Right genital verruca and furca, from lateral side, ♀. ×475.
6. Lower lip; the tongue-like part directed posteriorly, ♀. ×305. California, Carmel Bay.

shell; it ends at postero-dorsal corner of shell. At a rather great distance from and about parallel to posterior margin of shell, a similar ridge occurs (= posterior main ridge); it joins the last-mentioned ridge just in front of postero-dorsal corner of shell; in most specimens it also joins the ventral main ridge; sometimes, however, its ventral half is rather low and irregular (text fig. XIX, 2 of female), and its connection with the ventral ridge can even be broken. Just inside posterior margin and inside posterior half of ventral margin of shell, there is a low and rather inconspicuous ridge. Greater part of the surface of shell is covered with rather large, deep, and rounded to more or less angular cavities, arranged in about the manner shown in the accompanying figures. Just below postero-dorsal ridge, there are two longitudinal rows of cavities, separated by a rather narrow ridge; anterior cavity of upper row usually much larger than the others. On ventral half of shell cavities are arranged in more or less distinct rows which more or less distinctly radiate from center of valve. At about half the height of shell, there is a usually rather broad longitudinal zone, running somewhat upwards and backwards; this, like the ridges, is either perfectly smooth or marked with only a few very small cavities. Outside main ridges some more or less large cavities also occur (Pl. III, fig. 6). Bottoms of cavities either smooth or more or less rough. Hairs along margin about as in *C. (C.) montereyensis*, their number rather variable. Color of inner lamella of shell blue-greyish; when the undissected animal is regarded by reflected light, it has a bluish-black color. No dark fields to be detected, when shell is regarded by transmitted light (of course, with the exception of ridges).

First antenna: Of about same strength as in *C. (C.) montereyensis*, but fourth joint slightly longer relatively (see description of the subgenus). Pilosity: First joint about as in the mentioned species. Long hairs and the pectination along anterior edge of second joint more or less reduced; in some specimens there are but a few long hairs near proximal boundary of joint and a short distal pectination. Furthermore, the row of hairs on lateral side of the two distal joints sometimes rather poorly developed.

August 24, 1928

Second antenna (text fig. XIX, 3 and 4): Bristle on first endopodite joint somewhat shorter than in C. *(C.) montereyensis*. The medial one of the three bristles at about middle of posterior side of second endopodite joint has same type as the postero-lateral one of these bristles but is only about half as long or somewhat longer; both of these bristles finely pectinated. The shorter of the two anterior bristles of this joint furnished with a number of rather long hairs. Positions of these two groups of bristles about same as in Pl. XXXV, fig. 19, G. W. Müller, 1894. Along postero-distal edge of this joint, there is a number of very short, fine hairs. The longitudinal row of hairs on medial side of protopodite seems to be absent in some specimens.

Mandible: Masticatory joint: The next to the posterior pair of teeth of pars incisiva about as large as the adjoining pairs. On anterior side of dorsal half of this joint, there is a rounded hump. Endopodite: First joint: The two short ventro-distal bristles relatively short, being only about half as long as in text fig. VII, 9 of C. *(C.) montereyensis*. The dorso-distal bristle of this joint relatively long; usually somewhat longer than the longest bristles of distal joint. The longitudinal row of hairs on medial side of second joint seems to be absent at least in some specimens.

Maxilla: The four dorso-distal bristles on first joint of palp almost naked.

Fifth limb: Exopodite usually slightly longer, when compared with protopodite, than in C. *(C.) montereyensis;* and in some cases it has not so strong walls as in this species. Bristle on posterior side of protopodite has about same type as in C. *(C.) montereyensis*, ♂. Bristle on the second exopodite joint distinctly weaker. End claw almost naked.

Sixth limb: Exopodite somewhat longer relatively than in C. *(C.) montereyensis;* relative lengths of joints about as follows:

Protopodite $\frac{8}{13}$ Exopodite I. $\frac{8}{9.5}$ II. $\frac{8}{6.5}$ III. $\frac{7}{6.5}$

Of the three bristles on anterior side of protopodite, the two distal ones are somewhat shorter than in C. *(C.) montereyensis;* the one at about middle about as long as this side.

Other bristles of this limb about as in male of the mentioned species. End claw almost naked.

Seventh limb: Exopodite usually slightly longer, when compared with protopodite, and perhaps slightly more slender than in *C. (C.) montereyensis*. Protopodite: The proximal bristle on anterior side somewhat better developed than in the mentioned species, but still almost vestigial; the middle one of the three bristles on this side usually somewhat shorter than this side; the bristle at knee also in most cases somewhat shorter than in *C. (C.) montereyensis*. Bristle on posterior side of this joint about as long as in the mentioned species or but slightly shorter. Exopodite: Bristle of first joint has about same type as corresponding bristle in *C. (C.) montereyensis*, and is about as long as distal height of this joint, or slightly longer or shorter. End claw sometimes about as strong as in *C. (C.) montereyensis*, sometimes slightly weaker.

Brush-shaped organ: Has about same type as in *C. (C.) montereyensis*, but is slightly broader and more rounded distally than in figure 18 of this species.

Penis (Pl. VI, fig. 4): Vas deferens has spiral thickening. Ductus ejaculatorius has a rather short, free tube. Copulatory appendage rather short, of about same type on both penes.

Description: Female—

Shell (text fig. XIX, 2 and Pl. III, figs. 2, 6, 7): Length, 0.64 to 0.72 mm., thus somewhat smaller than the male; length: height, about 1.80 to 1.86:1; length: breadth, about 2.3:1. Of about same type as that of male, but somewhat higher relatively. Sometimes serrulation of anterior margin of shell is so weak that it is almost indistinguishable.

Second antenna: The medial and postero-lateral ones of the three bristles at about middle of posterior side of second endopodite joint are about the same as in male. The shorter of the two bristles on anterior side of this joint nearly naked. Positions of these two groups of bristles and pilosity about same as in male.

Mandible: Resembles that of male; or the dorso-distal bristle of first endopodite joint is somewhat shorter, sometimes even of about same relative length as in text fig. VII, 9 of *C. (C.) montereyensis*.

Fifth limb: Bristle on posterior side of protopodite and the one on first exopodite joint are of about same types as in *C. (C.) montereyensis*, ♀.

Sixth limb: Bristle on posterior side of protopodite has about same type and size as corresponding bristle of fifth limb. Bristle of first exopodite joint about as in female of *C. (C.) montereyensis.*

Seventh limb: Bristle on first exopodite joint of about same type and relative length as in *C. (C.) montereyensis*, or slightly shorter.

Genital verruca: Somewhat irregular in shape, with a decided sinuation postero-ventrally (text fig. XIX, 5).

Transverse rows of spines on back of posterior part of body rather weak and irregular, sometimes even absent.

Remarks: All organs were closely examined in two mature males and three mature females. Of the remaining specimens the shells alone were measured and examined.

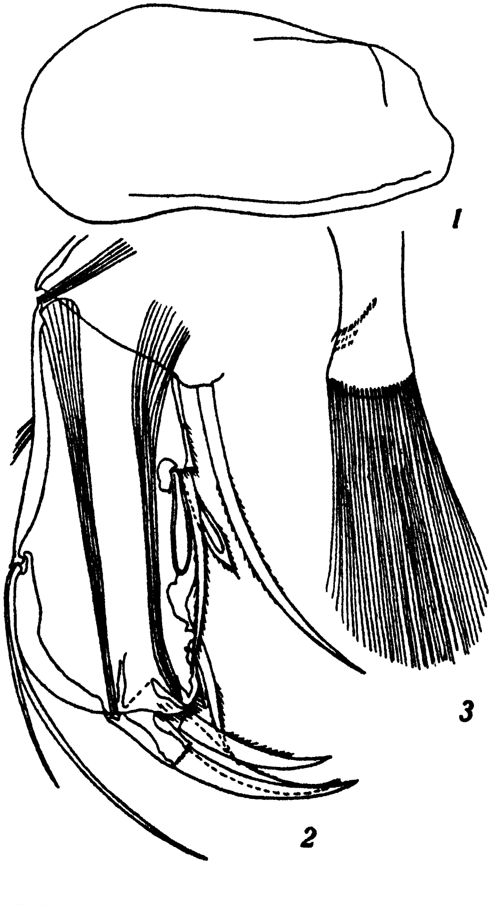
Habitat: **California: Pacific Grove,** just outside Hopkins Marine Station; in tide-pool, on calcareous algæ; 17.XI.1920: One juvenis, 0.59 mm. long. **Carmel Bay** (type locality): Tide-pool, on holdfasts of algæ; 23.XI.1920: One mature male, three mature females, and three juvenes (two of these juvenes were 0.58 mm. long; the third measured 0.43 mm.). Tide-pool, on roots of eelgrass; 20.I.1921: Two mature males, four mature females, and two juvenes (length of juvenes, 0.56 and 0.45 mm.). All specimens living, when taken. The females in sample from January 20th measured 0.70 to 0.72 mm.; longest female in sample of November 23d measured only 0.69 mm. All samples taken by the author.

C. (Cythereis) platycopa, new species

Plate VI, fig. 7; text fig. XX.

Description: Male—

Shell (text fig. XX, 1): Length, about 0.67 mm.; length: height, about 1.95:1. Seen from the side: Left valve has about same shape as in *C. (C.) pacifica*, but dorsal margin is not quite so evenly convex, and upper part of posterior margin is slightly sinuated. Postero-ventral beak of right valve has almost the same shape as in *C. (C.) pacifica.* Seen from



Text fig. XX. *Cythereis* (*Cythereis*) *platycopa*, n. sp., ♂, type.
1. Left valve from the side. ×85.
2. Endopodite of left second antenna, from the lateral side. ×440.
3. Brush-shaped organ. ×1170. California, Pacific Grove.

below, shell has about same shape as in the mentioned species. Sculpture of surface was, unfortunately, partly destroyed in the recorded specimen; however, it appears to be almost perfectly of the characteristic type of *C. (C.) pacifica.* When shell is seen from the side, postero-dorsal ridge touches dorsal margin. (This great similarity shows that, even in this genus with its elaborate sculpture of the shell, it is impossible to de termine a species by its shell alone.) Hairs of margin about as in C. *(C.) pacifica.*

First antenna: Fourth joint somewhat more elongated than in C. *(C.) montereyensis,* being about $\frac{10}{8}$, according to scale used in the subgeneric description. Claw of third joint slightly weaker than in most of the other species of the subgenus, and its tip reaches to about the point of attachment of the next claw. Bristle in front of the proximal claw of fourth joint rather short, being about one-third shorter than this claw. The short latero-distal spine of this joint somewhat smaller than in fig. 5 of C. *(C.) montereyensis.* I was unable to detect any longitudinal rows of hairs on first joint (absent ?).

Second antenna (text fig. XX, 2): .Left antenna—Posterior bristle of first endopodite joint almost as long as posterior side of second endopodite joint. Second endopodite joint: Does not grow narrower distally, as in all the remaining species of this subgenus examined by me; on the contrary, it is somewhat broader distally than proximally. The part of anterior margin, which is distal to the two bristles, is strongly but evenly convex. The group of three bristles on posterior side of this joint is situated somewhat proximally to middle; its postero-lateral bristle has a moderately strong pectination; its antero-lateral, sensorial, bristle is rather strikingly larger than usual; its medial bristle has about same size and shape as the antero-lateral one but is pointed distally, with thick walls, and furnished with short, fine hairs; the antero-lateral and medial bristles are about half as long as the postero-lateral bristle of this group. The postero-distal bristles of this joint are slightly more proximal than in most species of this subgenus. The longitudinal row of hairs on medial side of protopodite seems to be absent; and the distal hairs of second endopodite joint seem to be finer than in C. *(C.) montereyensis.* Right antenna—Differs from left one in having second endopodite joint distinctly less broadened distally; it is almost as narrow as in most species of this subgenus (proportion between the proximal and distal widths about 25:21).

Mandible: Masticatory joint: The next to the posterior pair of teeth of pars incisiva very small. There is a rounded hump on anterior side of dorsal part of this joint.

Maxilla: The long one of the four dorso-distal bristles of first joint of palp has short hairs or is almost naked.

Fifth limb: Relative lengths of joints, as well as strength of limb, about same as in *C. (C.) montereyensis*. Relative lengths and types of bristles about same as in male. Bristle on posterior side of protopodite seems, however, to be somewhat longer; and bristle on first exopodite joint perhaps slightly weaker. End claw almost naked. Distal pectination of joints very weak, or not developed at all.

Sixth limb: Relative lengths of joints, as well as strength of limb, about same as in *C. (C.) montereyensis*. Bristles about as in *C. (C.) montereyensisi*, ♂. The middle one on anterior side of protopodite, however, about as long as this side. Bristle of first exopodite joint about two-thirds to three-fourths as long as second exopodite joint. End claw almost naked. Distal pectination on joints rather weak.

Seventh limb: First exopodite joint slightly more elongated than in *C. (C.) montereyensis*. Bristles of protopodite about as in *C. (C.) glauca*. Bristle on first exopodite joint about as long as corresponding bristle in *C. (C.) montereyensis* but distinctly weaker. Distal pectination of joints somewhat weaker than in the mentioned species.

Brush-shaped organ (text fig. XX, 3): Differs from that of *C. (C.) montereyensis* in the following respects: Somewhat shorter relatively with distal part broader and somewhat more rounded, and with distal bristles somewhat more numerous (about fifty to sixty) and somewhat longer relatively.

Penis (Pl. VI, fig. 7): Vas deferens has spiral thickening. Ductus ejaculatorius has a rather short, free tube. Copulatory appendage has same type in both penes; it is rather long and narrow; and its distal part is somewhat widened and rounded.

Remarks: The alcohol used to preserve the only recorded specimen of this species was, unfortunately, slightly acid, and softened the shell. Thus I became unable to give a certain and detailed description of the sculpture of the shell, and even my description and figure of the outline of the shell must be regarded as somewhat uncertain. The peculiar and interesting type of the second antenna and the fact that the other organs were in a good condition, allowing a detailed description, overcame my hesitation to include this species in the present treatise.

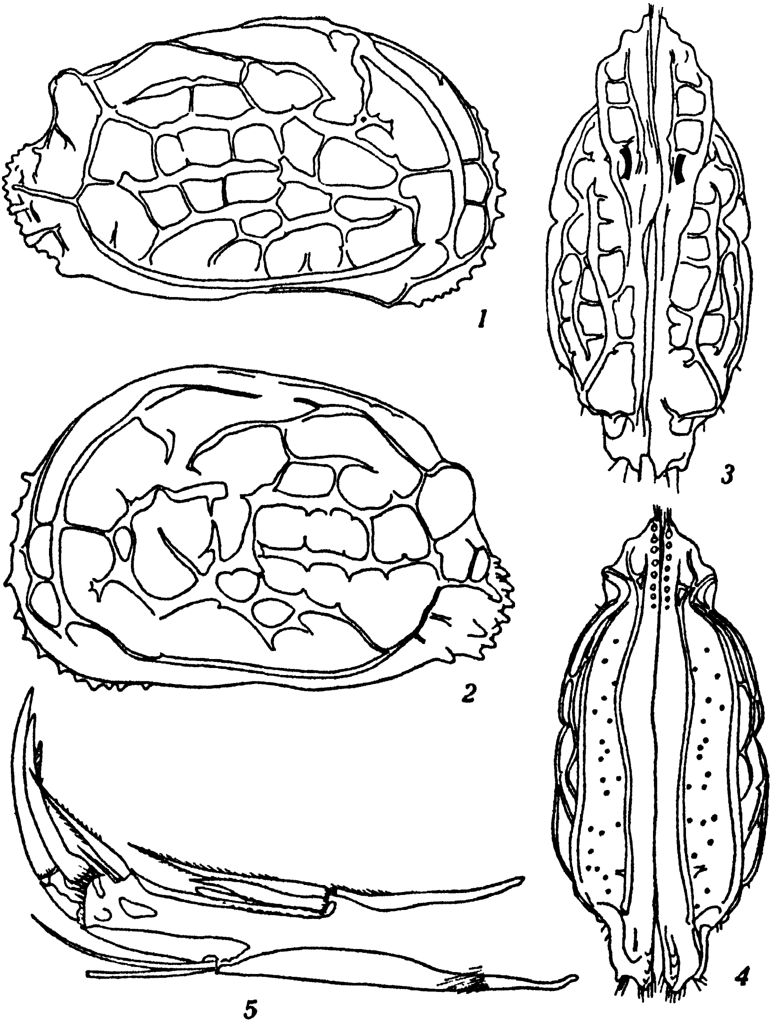
Habitat: **California: Pacific Grove** (type locality); depth, about 10 m.; 15.XII.1920: One mature male.

C. (Cythereis) aurita, new species

Plate VI, figs. 5 and 6; text fig. XXI.

Description: Male—

Shell: Length, 0.83 to 0.85 mm.; length: height, about 1.70 to 1.75:1; length: breadth, about 2:1. Seen from the side: Left valve: Sub-rectangular, highest in front of middle, at about anterior hinge-tooth, and with anterior half somewhat larger than posterior. Dorsal margin evenly and gently convex; sometimes of about same shape as in text fig. XXI, 2 of female, sometimes slightly more, sometimes slightly less convex than in this figure; slopes gently posteriorly and joins anterior and posterior margins with broadly and well rounded corners. Anterior margin of valve has about fifteen (twelve to sixteen) more or less powerful, short spines; in some (old ?) specimens, these spines were more or less worn out. Posterior extremity of valve produced, somewhat below middle, in a rather prominent but broadly, in some specimens somewhat irregularly, rounded beak-like process, which is furnished with a somewhat varying number of more or less strong spines of different sizes (about as in accompanying figures); the part of posterior margin, which is dorsal to this beak, gently sinuated to almost straight. Anterior half of ventral margin almost straight, posterior half gently convex. Right valve (text fig. XXI, 1): Rather strikingly lower than the left. Dorsal part of posterior margin somewhat more sinuated than in left valve. Same is true in the case of anterior half of ventral margin; the latter is sometimes, as in text fig. XXI, 1, marked off from anterior margin by a slightly developed corner. Seen from above and from below (text figs. XXI, 3 and 4), shell is oblong and has an irregular, somewhat rounded, hexagonal shape; with sub-parallel sides, which are rather deeply notched in middle and converge sinuously and rather abruptly towards the obliquely truncated extremities. Sculpture of surface very characteristic and ap-



Text fig. XXI. *Cythereis* (*Cythereis*) *aurita*, n. sp., not type.
1. Right valve from the side, ♂. ×77.
2. Left valve from the side, ♀. ×81.
3. Shell from above; anterior end above, ♂. ×68.
4. Shell from below; anterior end above, ♂. ×68.
5. Two distal joints of endopodite of left second antenna, from medial side, ♂. ×375. California, Pacific Grove.

parently rather constant; at any rate it showed but slight variations in specimens examined. Generally speaking, the only variations established were rather slight differences in shapes and heights of ridges (main ridges, as well as ridges separating depressions); sometimes two depressions were united, the dividing ridge being absent; or an additional depression was more or less well developed. As a rule, the sculpture was of about the type shown in text fig. XXI,' 1. Although figures are not shaded, they presumably give a fairly clear idea of sculpture; it should be kept in mind that the narrow ridges in these figures, i.e., generally speaking, the vertical ones, are more or less low; the broad, horizontal, on the other hand, are more or less high. Along and about parallel to anterior margin of shell, two rather narrow ridges are found, one fairly low close by margin, and one high and sharply marked at some distance inside the other; these ridges are united by a few (three or four), usually low ridges; the outer one of them is continued by a low ridge along ventral margin; the inner one sometimes joins main ventral ridge. Close by dorsal margin of shell, there is a rather marked ridge, which on left valve continues almost along entire margin, on right valve only along its anterior half. Ventral main ridge high, rather narrow, and connected with posterior main ridge. Posterior main ridge runs at a distance from posterior margin of shell somewhat greater than average distance between ventral ridge and ventral margin of shell. Ventral and posterior main ridges of about same type, and they form together almost an arc; from this arc one to three spur-like, rather low ridges issue to posterior beak-like process of shell. At about postero-dorsal corner of shell, posterior ridge is connected with a somewhat ear-shaped, irregular ridge (from which character the species has been named); this ridge surrounds a rather deep depression and, when shell is seen from the side, often covers margin of shell. From a point somewhat below eye, a narrow and high ridge runs in a more or less irregular curve upwards and backwards, and joins the ear-shaped postero-dorsal ridge; in the low right valve, this ridge partly covers dorsal margin of valve, when the latter is seen from the side; not so, however, in the case of left valve. The part of the surface inside the main ridges is covered with rather large and very deep depressions of irregular shapes, arranged more or less distinctly in a few longitudinal rows and divided by rather narrow and in most cases very marked ridges. The longitudinal of these separating ridges are about as high as main ridges; most of the vertical ones are frequently somewhat, though rather slightly, lower; heights of vertical walls, however, somewhat variable. Pores of surface about as in *C. (C.) montereyensis;* it is to be noticed that the small, irregularly scattered rings of text fig. XXI, 4 represent pores, and those arranged in rows along anterior part of margin represent spines. Hairs along anterior margin and along anterior part of ventral margin of shell are about of the same number as, or slightly more numerous than, in *C. (C.) montereyensis;* furthermore, they may be somewhat narrower and longer than in this species. Hairs along margin of posterior beak-like process of shell somewhat fewer than in the species mentioned, and, as in the case of those along anterior margin of shell, somewhat narrower. The part of the shell inside inner line looks yellowish-brown (due to color of inner lamella); outside this line valves are more or less milky white.

First antenna: Fourth joint somewhat more elongated than in *C. (C.) montereyensis,* being about $\frac{9}{8}$, according to scale used in description of the subgenus. Long claws are somewhat, though rather slightly, longer relatively than in most species of this subgenus. Bristle in front of the proximal claw of fourth joint relatively short, being about one-third to one-half shorter than the mentioned claw. Short antero-distal spine of this joint very small, being only about half the size of this claw in fig. 5 of *C. (C.) montereyensis.* The two long distal claws, perhaps, not so strong distally as in this figure. Pilosity: On lateral side of first joint there is a longitudinal row of hairs similar to that in *C. (C.) montereyensis.* On medial side of this joint, however, such a row seems always to be absent. Long hairs on anterior side of second joint somewhat reduced in number.

Second antenna (text fig. XXI, 5): Second endopodite joint somewhat more slender and also somewhat longer relatively than in *C. (C.) montereyensis.* Relative lengths of joints about as follows:

Protopodite $\frac{10}{9}$ Endopodite I. $\frac{7}{3}$ II. $\frac{18.5}{16}$ III. 2

The medial one of the three bristles at about middle of posterior side of second endopodite joint somewhat irregularly lanceolate, somewhat more than half the length of the postero-lateral bristle of this group, has thick walls, and is furnished with fine, short hairs; the postero-lateral of these bristles has a moderately strong pectination; the antero-lateral bristle is somewhat longer than usual. Position of this group and of that on anterior side of this joint about the same as in Pl. 35, fig. 19, G. W. Müller, 1894. Claws of end joint somewhat longer than usual; the antero-distal one of them about four times as long as anterior side of end joint; the proximo-lateral one slightly shorter than the proximo-medial one. On both medial and lateral sides of protopodite, there is a longitudinal row of fine, rather short hairs.

Mandible: Masticatory joint: The next to the posterior pair of teeth of pars incisiva small. There is a rounded hump on anterior side of dorsal half of this joint. Ventro-distal bristle of second protopodite joint often furnished with but short hairs. Row of hairs on medial side of second endopodite joint seems sometimes to be represented only by a number of hairs of moderate length near distal boundary of joint.

Maxilla: The long one of the four dorso-distal bristles on first joint of palp is almost naked.

Fifth limb: Relative lengths of joints somewhat variable but usually about as follows:

Protopodite $\frac{10}{13}$ Exopodite I. $\frac{7}{9}$ II. $\frac{6.5}{6}$ III. $\frac{6}{5.5}$

First exopodite joint thus somewhat longer relatively than in *C. (C.) montereyensis.* Exopodite also somewhat more slender than in this species. Bristle on posterior side of protopodite about as long as in *C. (C.) montereyensis,* ♂, but non-annulated and naked or almost so. Other bristles about as in *C. (C.) montereyensis.* End claw perhaps slightly weaker. Distal pectination of joints relatively weak.

Sixth limb: Relative lengths of joints about as follows (according to scale used in fifth limb):

Protopodite $\frac{12}{15}$ Exopodite I. $\frac{9.5}{11.5}$ II. $\frac{7.5}{6.5}$ III. $\frac{7}{6.5}$

First exopodite joint thus somewhat longer relatively than in *C. (C.) montereyensis.* Moreover, exopodite slightly more slender than in this species. The middle one of the three bristles on anterior side of protopodite about as long as this side; the other bristles, including that of first exopodite joint, about as in female of *C. (C.) montereyensis.* End claw weakly pectinated, almost naked.

Seventh limb: Relative lengths of joints about as follows (according to scale used in the two preceding limbs):

Protopodite $\frac{12}{15}$ Exopodite I. $\frac{12}{13.5}$ II. $\frac{7}{6}$ III. $\frac{7.5}{7}$

Thus first exopodite joint distinctly longer relatively than in *C. (C.) montereyensis.* Exopodite slightly more slender than in this species. The long bristles of protopodite usually about as in *C. (C.) glauca;* bristle of first exopodite joint about as in *C. (C.) montereyensis.* End claw is slightly weaker than in the last-mentioned species. The same is also true in the case of the two preceding limbs; differences, however, so small that they hardly can be reproduced in a figure on the scale used in this paper.

Brush-shaped organ: About intermediate between that of *C. (C.) montereyensis* and that of *C. (C.) platycopa.* Distal bristles distinctly longer than stem. No hairs appear to be present.

Penis (Pl. VI, figs. 5, 6): Vas deferens seems to have no spiral thickening; at any rate, I was not able to detect it. Ductus ejaculatorius has a rather short, free tube, the distal part of which is narrow. Copulatory appendage has nearly the same type in both penes; it is somewhat pointed distally and has a notch at about middle of ventral side.

Lips: Cross-strip of the A-shaped chitinous support above upper lip seems sometimes to be absent. Unpaired appendage of lower lip is, at least in some cases, somewhat irregular.

Description: Female—

Shell: Length, 0.74 to 0.83 mm.; length: height, about 1.6 to 1.7:1; length: breadth, about 1.9:1. Of about same type as in male (text fig. XXI, 2).

Second antenna: Second endopodite joint: The medial and postero-lateral ones of the three bristles of posterior side of joint are similar in structure, with rather fine pectination; the antero-lateral of these bristles perhaps slightly shorter than in male. Position of this group of bristles and that of group on anterior side of this joint about the same as in male. Pilosity also resembles that of male.

Fifth limb: Bristle on posterior side of protopodite about as in *C. (C.) montereyensis*, ♀.

Sixth limb: Differs from that of male in having posterior bristle on protopodite of about same type as that of the corresponding bristle on fifth limb in *C. (C.) montereyensis.*

Seventh limb: About as in male.

Genital verruca and hind part of body about as in *C. (C.) montereyensis.*

Remarks: Two males and three females were examined. The shells of all the recorded specimens were measured and examined.

Habitat: **California: Pacific Grove,** just outside Hopkins Marine Station (type-locality): In tide-pool, on calcareous alga; 17.XI.1920: One empty shell. On holdfasts of *Macrocystis;* depth, 2 m.; 23.XI.1920: Two males (one of which was dead, when taken), six mature females (living), and one empty shell. On holdfasts of *Macrocystis;* 28.I.1921: Eight specimens (two of which were dead when taken). Collected by the author.

Subgenus Pseudocythereis, new subgenus

Description:

Shell: With the same characteristics as in the subgenus *Cythereis.* The bristles along the anterior margin and along the anterior part of the ventral margin are narrow and either simple or bifurcate.

First antenna: Six-jointed, the fourth joint of the subgenus *Cythereis* being divided into two distinct joints. The number and positions of the bristles are the same as in the mentioned subgenus. The relative lengths of the bristles are somewhat variable. The bristle of the third joint is relatively long; its tip reaches rather far beyond the point of attachment of the claw of the fourth joint. The pilosity is about the same as in the subgenus *Cythereis.*

Second antenna: Of somewhat varying types. With the same number of joints and with the same bristles as in the subgenus *Cythereis.* The exopodite is well developed in the males; three-jointed. The end claws of the endopodite are relatively long; the distal one of them is longer than half the length of the second endopodite joint. The chitinous support of the proximal part of the protopodite of about the same type as in the subgenus *Cythereis.*

Mandible: Of about the same shape as in *Cytheretta rubra* (Pl. XXXIX, figs. 17 and 18, G. W. Müller, 1894), but with the same bristles as in the subgenus *Cythereis.* Masticatory joint: The toothed edge of the pars incisiva has a moderate width. Of its teeth, the anterior one is simple, smooth, triangular, and somewhat larger than the others. The five following ones are bifurcate; their two points of slightly different sizes; they decrease somewhat in size the more posteriorly they are situated. Behind these teeth there are two rather short, bristle-like appendages. Between teeth nos. 1 and 2, one or two rather fine and short bristles are to be found; and a similar, but somewhat shorter, bristle occurs between teeth nos. 2 and 3. The bristle on the anterior side of this joint has about the same type and relative length as in the subgenus *Cythereis.* The palp is four-jointed. Its two distal joints are subequal, the distal one being somewhat longer relatively than in the subgenus *Cythereis.* The second endopodite joint varies somewhat in shape. In *C. (Pseudocythereis) spinifera* it has about the same narrow shape as in the figure noted above; in *C. (P.) falcata* it has a shape about intermediate between that of the mentioned species and that of the subgenus *Cythereis* [*C. (C.) montereyensis,* text fig. VII, 9]. Second protopodite joint: The two bristles of about the same types and relative lengths as in the subgenus *Cythereis.* The epipodial appendage has five bristles of about the same types and relative lengths (see the descriptions of the species) as in fig. 17 of *Cytheretta rubra* referred to above; all these bristles have fine and rather long hairs. Endopodite: First joint: The dorso-distal bristle seems usually to be somewhat longer relatively than in the subgenus *Cythereis,* being about as long as the second endopodite joint. The four ventro-distal bristles have about the same types and relative lengths as in the figure of *Cytheretta rubra,* referred to above; the two shorter ones with some long hairs. Second joint: The two ventral bristles are of about the same types and relative lengths as in the subgenus *Cythereis,* but situated near the distal boundary of the joint. Of the eight dorso-distal bristles, five are of the same long and narrow type as the corresponding bristles in the subgenus *Cythereis* and have about the same relative length as in this subgenus. Of these five bristles, four are non-annulated and naked or furnished with exceedingly fine and short hairs; the remaining one is annulated and has fine, short hairs. Of the three remaining ones of these eight bristles, two are rather short (about as long as the distal joint or somewhat shorter), non-annulated or almost so, and furnished with short, fine hairs. One, situated somewhat ventrally and medially to the others, is rather slightly longer than the distal joint, non-annulated, and furnished with a number of long hairs. (This last bristle evidently corresponds to the long, annulated dorso-distal bristle of this joint in the subgenus *Cythereis.)* Distal joint: With four bristles. One of these is about twice as long as the distal joint and has about the same type as the long ventro-distal bristle of the preceding joint. The other three are rather weak, non-annulated, and about as long as or somewhat longer than this joint. One of them has long hairs, the other is naked or almost so. Pilosity: Of about the same type as in the subgenus *Cythereis.* Second endopodite joint: The hairs in the row of hairs on the medial side are moderate in length. Dorsally to this row another longitudinal row of moderately long hairs occurs. Along the lateral side of the distal joint, there is a longitudinal row of rather long hairs, and similar hairs also occur medio-distally.

Maxilla: The epipodial appendage has about the same type and the same number (sixteen) of marginal bristles as in the subgenus *Cythereis.* The endites and the endopodite about as in *Cytheretta rubra* (Pl. 39, fig. 11, G. W. Müller, 1894). Each of the three endites has seven bristles of moderate length and strength; the average length and strength about the same as in the case of the second and third endites of *C. (Cythereis) montereyensis* (text fig. VII, 13 of this species). First endite: Just as in the subgenus *Cythereis,* one bristle is somewhat longer than the others and situated somewhat proximally to these; five are rather narrow and but slightly widened basally; one is rather thick at the base. All these bristles are non-annulated or almost so; some are naked or almost so; some have fine and more or less long hairs. Second endite:

Five of the bristles are rather narrow and but slightly widened at the base; two are characterized by thick bases. Third endite: One or two have thick bases; the others are narrow with slightly widened bases. The bristles of the second and third endites of about the same types as those of the first endite; non-annulated or almost so; some naked or almost so; some furnished with fine, more or less long hairs. Palp: First joint: This has four more or less distinctly annulated dorso-distal bristles; the longest one of these is about as long as the dorsal side of this joint; the three others of somewhat different lengths, about half as long as the longest. The longest has fairly long hairs; similar hairs also occur on one or two of the short ones. Disto-laterally on this joint there are two bristles. These have about the same types and sizes as the corresponding bristles in the subgenus *Cythereis* and are situated on a small, scale-like process. Distal joint: Length slightly variable. With three rather weak distal bristles of somewhat different lengths in the various species; these bristles have hairs of moderate length or are almost naked. Pilosity: Near the dorsal margin of the first joint of the palp, there is a longitudinal row of rather long hairs. Hairs also occur (at least sometimes) on the second and third endites.

Fifth limb: Of about the same shape and with the same bristles as in the subgenus *Cythereis*. Of the two bristles at about the middle of the anterior side of the protopodite, the short one is situated somewhat proximally to the other. There is no complicated chitinous support at the knee (such as is to be found in the subgenus *Cythereis)*.

Sixth and seventh limbs: Of about the same types and with the same bristles as in the subgenus *Cythereis*. There is no complicated chitinous support at the knee. The armament of the end claw and of the second exopodite joint sometimes of rather aberrant types *(spinifera)*.

Brush-shaped organ: Of about the same type as in the subgenus *Cythereis*.

Penis: The main type about the same as in the subgenus *Cythereis*. For the same reasons as in the mentioned subgenus, it may be convenient to postpone a detailed description of this organ.

The furca of the male has the same bristles as in the subgenus *Cythereis*. The size of the verruca varies.

The larger part of the chitinous skeleton has a yellowish color; frequently a light yellowish color.

Remarks: Although the two members of the subgenus agree in some fairly important respects, they show so many differences that I am very doubtful as to their assignment to the same subgenus. Some of the similarities, e.g., the number of joints in the first antenna and the absence of the complicated chitinous supports at the knees of the fifth, sixth, and seventh limbs, presumably are primitive. The assignment of *C. (P.) falcata* to this subgenus should be regarded as tentative.

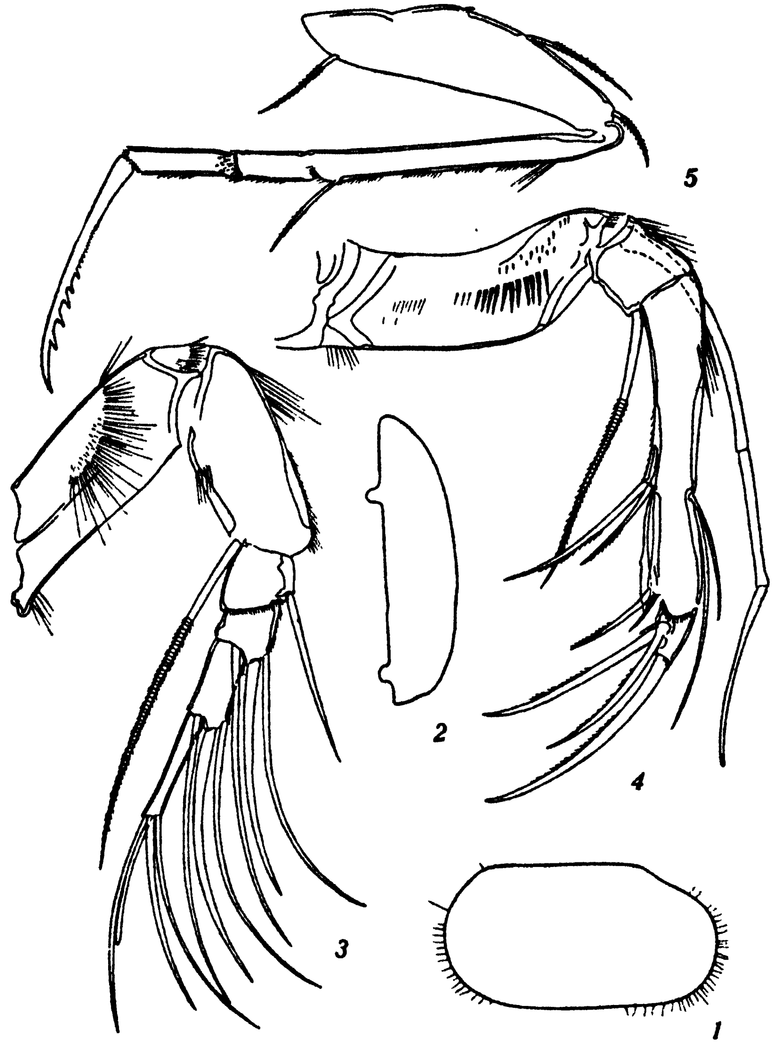
The type of this subgenus is *C. (P.) spinifera.*

C. (Pseudocythereis) spinifera, new species

Plate II, fig. 8; Plate V, fig. 5; text fig. XXII.

Description: Male—

Shell (Pl. II, fig. 8): Length, about 1.05 to 1.06 mm.; length: height, about 1.9:1; length: breadth, about 1.97:1. Seen from the side: Left valve: Dorsal and ventral margins almost straight and sub-parallel to each other; the dorsal has a slight hump just above eye and is marked off from posterior margin by a distinct but rounded corner. Anterior margin lacks teeth and crenulation. Posterior margin and posterior part of ventral margin well rounded, forming almost an arc; without teeth or crenulation. Right valve (text fig. XXII, 1): Differs from left mainly in the following respects: Somewhat lower; upper part of anterior margin somewhat more flattened, slightly sinuated; no distinct hump above eye; and postero-dorsal corner of valve somewhat less distinct. Seen from above (text fig. XXII, 2), shell is ovate, broadest at about middle, its posterior extremity somewhat more broadly rounded than anterior, and its side-contours fairly evenly curved. Surface covered with numerous closely-set, polygonal excavations of various shapes, of moderate size, subequal, and of moderate depth; some excavations arranged in rows more or less distinctly parallel to margin of shell. Bottom of each excavation marked by a number of small,



Text fig. XXII. *Cythereis* (*Pseudocythereis*) *spinifera*, n. sp., ♂. 3-5, From type specimen.

1. Right valve from the side. ×33.
2. Right valve from above. ×35.
3. Left first antenna from the medial side. ×220.
4. Left second antenna from the medial side. ×220.
5. Left seventh limb from the medial side. ×145. S. A. E.. station 24.

more or less rounded pits. Along anterior margin and along anterior part of ventral margin, there are about forty to fifty narrow, simple bristles of moderate length. Along posterior margin of shell, there is a number of similar bristles. When shell is regarded by transmitted light no dark fields are to be detected.

First antenna (text fig. XXII, 3): Of moderate strength and length, rather slender, most of the joints with rather thin walls; second and third joints, however, have walls of moderate thickness. Relative lengths of joints about as follows:

I. $\frac{14}{17}$ II. $\frac{13}{10}$ III. $\frac{3}{5}$ IV. $\frac{4}{2}$ V. $\frac{5}{5}$ VI. $\frac{6.5}{7}$

Bristle of second joint of about same type as in the subgenus *Cythereis,* distinctly annulated, its tip reaching somewhat beyond tip of antenna. Bristle of third joint moderate in strength, its length subequal to total length of anterior sides of the two distal joints. Of the three antero-distal bristles of fourth joint, one is rather strong, about as long as total length of the three distal joints, and slightly curved; the two others of moderate strength, subequal, and somewhat longer than the first. Three of the four bristles of fifth joint of about same types and lengths as the three bristles of fourth joint; the middle, claw-like one of them, just as the corresponding bristle of fourth joint, situated on a short, verruciform process; the remaining one of these four bristles is lateral and very weak and short, its length being subequal to the proximal width of the distal joint, and it points in about the same direction as the other bristles of this joint. Of the four bristles of the distal joint, the anterior is moderate in strength and about as long as total length of the three distal joints; one is a little shorter and stronger than the anterior. The two remaining ones are united at base (just as in the subgenus *Cythereis);* one of them has about the same length and strength as (or is slightly weaker than) the anterior of these four bristles; the other is narrowly claviform, sensorial, and usually somewhat more than half as long as its neighbor. All bristles of the four distal joints non-annulated and naked. Pilosity: On lateral side of first joint, there are two rows of rather short hairs running slantingly upwards and forwards, from a point somewhat dorso-distally to proximo-ventral corner of joint, to a point near middle of dorsal side. On medial side of this joint, at about middle of joint, there is a crescent-like row of hairs of different lengths. Second joint: Antero-proximally, there is a group of rather long hairs; along distal half of anterior side, a dense, rather short, and fine pectination occurs. Third joint: Pectination along medio-distal edge well developed. Fourth and fifth joints: Along entire anterior sides of these two joints, somewhat laterally, a dense, short, and rather fine pectination. On lateral side of end joint, a longitudinal row of fine hairs occurs; this is more spaced than pectination of the two preceding joints.

Second antenna (text fig. XXII, 4): Of moderate size, slender, walls of joints rather thin. Relative lengths of joints about as follows:

Protopodite $\frac{14}{13}$ Endopodite I. $\frac{4}{3}$ II. $\frac{20}{18}$ III. 4

Exopodite rather slender and somewhat longer than endopodite; second and third joints either subequal, or the third is slightly longer; both of them somewhat shorter than first joint. Endopodite: Posterior bristle of first joint about as long as or slightly shorter than posterior side of second joint, annulated, and furnished with very short hairs. Second joint: The two bristles on anterior side are naked and situated somewhat distally to middle of this joint; one of them about twice as long as the other; the shorter extends to about distal boundary of this joint. The group of three bristles on posterior side of this joint situated just opposite or slightly distally to the two bristles on anterior side. Of these three bristles, the postero-lateral is of moderate strength and about half as long as anterior side of this joint or slightly longer. The medial one is somewhat weaker than and somewhat more than half as long as the postero-lateral. The antero-lateral bristle is about as long as or slightly longer than the medial; its proximal half is narrow, its distal half lanceolate. Of the two postero-distal bristles of this joint, one is about as long as and somewhat stronger than the medial of the three last mentioned bristles; the other rather weak and only about half as long. Distal joint: Distal claw moderate in strength and about half as long as anterior side of first and second endopodite joints. The two other end claws are of somewhat different lengths;

the shorter, lateral, one of them is somewhat longer than half the posterior side of second endopodite joint. All bristles of the two distal joints are non-annulated; those on anterior side of second endopodite joint and the sensorial one of the group of three bristles on posterior side of this joint are naked; the others are very finely pectinated. Pilosity: Proximo-ventrally on protopodite, there is a number of hairs. On medial side of protopodite, a longitudinal row of rather long and strong spines (number of spines somewhat variable) and a number of scattered small spines and fine hairs occur. Dorso-distally on this joint, there is a group of rather short hairs. Pilosity of exopodite and of endopodite about the same as in the subgenus *Cythereis*. Of the two distal plates of second endopodite joint, the medial one is furnished with pectination of moderate strength; the lateral one with very fine pectination.

Mandible: Masticatory joint: Between teeth nos. 1 and 2 on toothed edge of pars incisiva, only one bristle was detected. Epipodial appendage: Posterior bristle somewhat longer relatively than in *Cytheretta rubra* (G. W. Müller, 1894, Pl. XXXIX, fig. 17). The dorso-distal bristle of the first endopodite joint with a moderate number of long hairs. The two short dorso-distal bristles of second endopodite joint about half as long as distal joint. Pilosity: At distal end of the longitudinal row of hairs on medial side of second endopodite joint, there is a number (about seven) of rather long spines, which sometimes are rather weak.

Maxilla: Length of distal joint and of its bristles about the same as in *Cytheretta rubra* (G. W. Müller, 1894, Pl. XXXIX, fig. 11).

Fifth limb: Of about same type and relative size as in *Cytheretta rubra* (G. W. Müller, 1894, Pl. XXXIX, fig. 9); the two distal joints subequal, and first exopodite joint somewhat longer than the second. Protopodite: Bristles on anterior side (including those at the knee) of about same types and relative lengths as in *C. (Cythereis) montereyensis* or slightly longer; the next to the proximal bristle somewhat stronger than the others; bristles at the knee of subequal thickness. Bristle on posterior side of this joint about as long as or somewhat longer than distal joint, swollen at base, and furnished with long hairs. Exopodite: Bristle of first joint about as long as or slightly shorter than second joint, rather weak, slightly annulated, and furnished with short, fine hairs, almost naked. End claw naked or almost so and has about the same length, strength, and shape as in the figure mentioned above. Pilosity: Of about same type as in *C. (Cythereis) montereyensis;* ventral side of exopodite almost naked.

Sixth limb: Differs from fifth limb mainly in the following respects: Somewhat larger, and first exopodite joint about as long as total length of the two distal joints. Protopodite: Bristles about of same types and relative lengths as in the mentioned species. (Of course, there is only one bristle at the knee.) Bristle on posterior side of this joint, however, rather narrow and sometimes furnished with short hairs. Exopodite: Bristle on first joint sometimes somewhat, though but slightly, longer relatively. End claw as weak as that on fifth limb but somewhat longer, being about as long as total length of the two distal joints. Pilosity: On posterior side of protopodite near the bristle, there is a small group of rather long hairs.

Seventh limb (text fig. XXII, 5): Somewhat more elongated than sixth limb (ratio between lengths of exopodites of sixth and seventh limbs, about 7:10). First exopodite joint distinctly longer than total length of the two distal joints (about 3:2); the two distal joints subequal. Protopodite: Of the three bristles on anterior side, the proximal is almost vestigial; tip of the middle one reaches to about distal boundary of joint; and the distal one (at the knee) is about half as long as the middle one. Bristle on posterior side of this joint about as long as, or somewhat shorter than, the middle of the bristles on anterior side of joint. The three well-developed bristles are rather weak, annulated, and furnished with short, fine hairs. Exopodite: Bristle on first joint about as long as, or somewhat longer than, second joint, rather weak or of moderate strength, non-annulated, and furnished with short, fine hairs. End claw fairly powerful, somewhat longer than total length of the two distal joints, and armed with a number of spines which increase in size and strength the more distally they are situated. Proximal spines are fine, the four or five distal ones are strong. Distances between distal spines rather great, subequal to lengths of spines; proximal spines closely-set; distal spine situated two to four times its own length from tip of claw. Pilosity: Protopodite seems to be naked except for a fine disto-lateral pectination. Exopodite: Along ventral side of first joint, there are four fields of short, fine hairs, proximally to which a group of rather long hairs occurs. Distally this joint is pectinated; pectination well developed on lateral side of joint, weak on medial side. The second joint has, ventrally, fine, short hairs; medio-distally, a fine pectination; and latero-distally, a series of spines, some of which (about four to five) are strong. Distal joint has a field of fine, short hairs on ventral side and is pectinated distally; pectination well developed on lateral side of joint, weak on medial side.

Brush-shaped organ: Somewhat wider than in *C. (Cythereis) montereyensis*. The distal bristles about as long as stem. No row of hairs seems to be present.

Penis: Both organs are of about type shown in Pl. V, fig. 5. Vas deferens has spiral thickening. Ductus ejaculatorius short and points downwards. Horn-like part is long and extends along entire ventral side of body of penis. Copulatory appendage has an irregularly and narrowly rounded postero-ventral process; anterior part of copulatory appendage of moderate length and height, and narrowly rounded distally.

Furca: The two long bristles are subequal; verruca, rather small.

Female: Unknown—

Remark: Three specimens were examined.

Habitat: **South Georgia**—S.A.E., Station 22, off **May Bay**, lat. 54° 17′ S., long. 36° 28′ W.; 14.V.1902; depth, 75 m.; clay with scattered algæ; temperature at bottom +1.5° C: One mature male. S.A.E., Station 24, off **Grytviken**, lat. 54° 22′ S., long. 36° 27′ W. (type-locality); 20.V.1902; depth, 95m.; clay: Two mature males (only chitinous parts left). On slides in the National Museum, Stockholm.

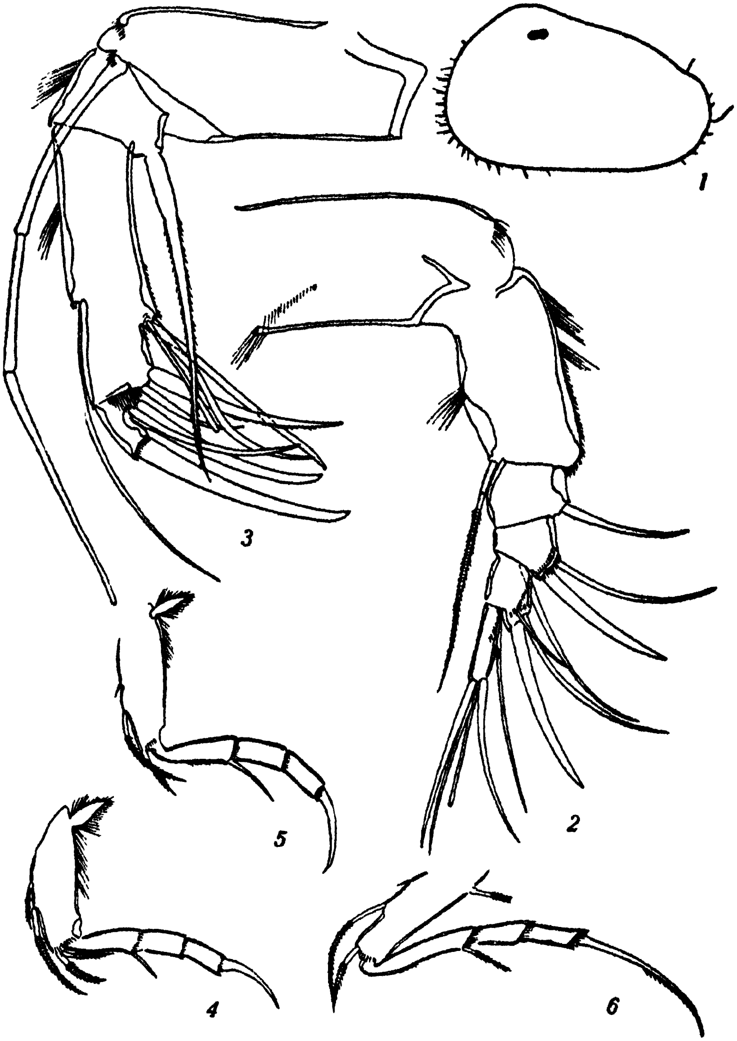
C. (Pseudocythereis) falcata, new species

Plate V, fig. 6; text fig. XXIII.

Description: Male—

Shell: Length, about 0.76 mm.; length: height, about 1.73:1. Seen from the side: Left valve (text fig. XXIII:1): Subtriangular, with greatest height situated somewhat in front of middle, at about anterior hinge-tooth. Anterior and posterior margins without teeth or crenulation; posterior extremity of valve rather narrowly and evenly rounded. Dorsal margin of valve gently arched, sloping rather steeply posteriorly; with a broadly rounded hump above eye and marked off from posterior margin by a broadly rounded corner. Ventral margin of valve almost straight, its posterior part forms with ventral part of posterior margin almost an arc. (Right valve broken in the only recorded specimen.) Sculpture of surface: Surface covered with closely-set, shallow, and angular excavations of moderate size; it seems not to have any strongly prominent (main) ridges. It is to be noted, however, that the greater part of the surface of the shell of the only specimen of this species examined was corroded; my description of the sculpture thus must be received with some reservation. Along anterior margin and along the anterior part of ventral margin of shell, there is a number of bifurcate bristles of moderate length or rather short. Along posterior margin of shell a few simple, narrow bristles occur, some of them moderate in length or rather short, some rather long. When shell is regarded by transmitted light, no dark fields are to be detected.

First antenna (text fig. XXIII, 2): Of moderate length and strength; second and third joints with rather strong walls. Relative lengths of the three proximal joints about the same as in *C. (Cythereis) montereyensis;* the fourth joint somewhat smaller than the third, its anterior side being about as long as or slightly longer than anterior side of third joint, its posterior side only about a third of the length of third joint; fifth joint strikingly narrower than its predecessor, its anterior and posterior sides subequal, about as long as or slightly shorter than anterior side of fourth joint; the distal joint about half as wide as its predecessor, of subequal width throughout its en-



Text fig. XXIII. *Cythereis* (*Pseudocythereis*) *falcata*, n. sp., ♂, type.
1. Left valve from the side. ×47.
2. Right first antenna from the lateral side. ×230.
3. Left second antenna from the lateral side. ×290.
4, 5 and 6. The left fifth, sixth, and seventh limbs from the lateral side. ×155. S. A. E. station 28.

tire length, and about as long as total length of fourth and fifth joints. Bristle of second joint has same type as the corresponding bristle in the subgenus *Cythereis* and is about as long as or slightly longer than total length of the four distal joints. Bristle of third joint of moderate strength and about as long as posterior side of second joint. Fourth joint: Of the three antero-distal bristles, the middle one is rather powerful, about as long as or somewhat longer than posterior sides of the three distal joints, and almost straight; the two others of moderate strength, subequal, and somewhat longer than claw. Fifth joint: Of the four bristles, three are of about the same type and lengths as bristles on fourth joint; the remaining one, corresponding to the short latero-distal spine in the subgenus *Cythereis,* is weak and about as long as distal joint. Claw and anterior narrow bristle situated on a rather short, verruciform process. Distal joint: Of the four bristles, two are of moderate strength and about as long as posterior sides of the three distal joints. The two remaining ones are (just as in the subgenus *Cythereis)* united at the base and both of them are narrow; one is about as long as, or slightly longer than, the first two of these four bristles; the other is claviform (sensorial) and about one-third shorter than its neighbors. All bristles of the four distal joints are non-annulated; the claw-like ones are very finely pectinated, the others naked or almost so. Pilosity: On lateral side of first joint only a few hairs are to be found. On medial side of this joint a pilosity of about same type as in *C. (Pseudocythereis) spinifera* occurs. Medio-distal pectination of third joint almost absent. Pilosity of the three distal joints somewhat weaker than in *C. (Pseudocythereis) spinifera.*

Second antenna (text fig. XXIII, 3): Of moderate length and rather strong. Relative lengths of joints about as follows:

Protopodite $\frac{14}{13}$ Endopodite I. $\frac{6}{4}$ II. $\frac{18}{15}$ III. 4

Exopodite rather slender and somewhat longer than endopodite; its distal joint relatively long; twice or almost twice as long as the middle joint, which is somewhat shorter than proximal joint. Endopodite: Posterior bristle of first joint relatively strong, about as long as anterior sides of the two distal joints, non-annulated or almost so, and furnished with fine, short hairs. Second joint: Of the two bristles on the anterior side, the longer is somewhat longer than anterior side of this joint; the remaining one somewhat more than half this length; both naked or almost so, and they are situated somewhat distally to middle of joint. The group of three bristles on posterior side of this joint is situated somewhat distally to the two bristles on anterior side. The postero-lateral and the medial ones of them are about as long as, or somewhat longer than, posterior side of this joint and of moderate strength. The postero-lateral is somewhat curved, the medial is almost straight; both naked or almost so. The antero-lateral of these three bristles is narrowly claviform and somewhat more than half as long as its two neighbors. Of the two postero-distal bristles of this joint, one is rather powerful, about as long as or slightly shorter than the medial of the three bristles just described, and furnished with fine pectination; the other bristle moderate in strength, about half as long as its neighbor or slightly more, and naked or almost so. Distal joint: The two proximal claws about as long as the powerful postero-lateral bristle of the second joint; the medial one of them about as strong as, or slightly stronger than, the last-mentioned bristle, the lateral one moderate in strength. End claw has about same type and size as the medial one of the two proximal bristles of this joint. All claws of distal joint naked or almost so. Pilosity about the same as in *C. (Cythereis) montereyensis*. Hairs on second endopodite joint rather long. Distal pectination of this joint is fine on both sides of limb. It is to be noted that the distal plates of this joint are not developed.

Mandible: Masticatory joint: Between teeth nos. 1 and 2 on toothed edge of pars incisiva, there are two bristles. Epipodial appendage and dorso-distal bristle of first endopodite joint about as in *C. (P.) spinifera*. Second endopodite joint: The two short dorso-distal bristles about as long as distal joint. There are no spines on this joint.

Maxilla: Distal joint rather short, almost square; its bristles of somewhat different lengths, the longest about thrice as long as joint, the shortest about twice as long as joint.

Fifth limb (text fig. XXIII, 4): Exopodite somewhat shorter, when compared with protopodite, than in *C. (Pseudo-*

cythereis) spinifera; just as in this species, walls of joints are rather thin. Protopodite: Types and relative lengths of bristles on anterior side about as in *C. (Cythereis) montereyensis,* the proximal one, however, somewhat shorter relatively. Bristle on posterior side of this joint about as long as distal joint, rather broad and furnished with long hairs. Exopodite: Bristle on first joint not quite so long as second joint, of moderate strength, non-annulated, and furnished with short, fine hairs, almost naked. End claw moderate in strength, about as long as first exopodite joint, evenly curved, and naked or almost so. Pilosity about same as in the subgenus *Cythereis.* Distal pectination of joints exceedingly fine. On ventral side of first exopodite joint, there is one or two small groups of hairs of moderate length. Ventral sides of the two distal joints seem to be naked.

Sixth limb (text fig. XXIII, 5): Differs from fifth limb mainly in the following respects: Somewhat larger. Protopodite: Proximal bristle on anterior side short, only about half as long as corresponding bristle of fifth limb. (Of course, there is only one bristle at the knee.) Exopodite: Bristle of first joint almost naked and somewhat longer, being about as long as or slightly longer than second joint. Long hairs on posterior side of protopodite somewhat fewer.

Seventh limb (text fig. XXIII, 6): This differs from the sixth mainly in the following respects: First exopodite joint somewhat longer relatively, being about as long as total length of the two distal joints. Bristle on posterior side of protopodite narrow, annulated, furnished with fine, short hairs, and probably rather long (broken in the only specimen recorded). Bristle on first exopodite joint has fine, short hairs. End claw narrow, gently curved, finely pectinated, and about as long as total length of first and second exopodite joints. All joints furnished distally with pectination of moderate strength. Ventral side of exopodite naked or almost so; no long hairs to be found on protopodite.

Brush-shaped organ: Has about same type as in *C. (Pseudocythereis) spinifera.*

Penis: Right and left organs of about the type shown in Pl. V, fig. 6. Vas deferens has spiral thickening. Ductus ejaculatorius sickle-shaped (a character from which this species has been named); its point directed upwards and forwards. Copulatory appendage rather large and fairly broadly triangular; its anterior extremity narrowly rounded; its postero-ventral process narrow and well pointed.

Furca: Verruca relatively large (about as long as postero-ventral process of copulatory appendage of penis), somewhat irregularly conical, and has a narrowly rounded point. Distally it has two bristles, one of which is somewhat shorter than the other. The short, third bristle located at about the middle of anterior side of verruca.

Female: Unknown—

Habitat: **South Georgia**—S.A.E., Station 28 (type-locality), lat. 54° 22′ S., long. 36° 28′ W.; 24.V.1902; depth, 12 to 15 m.; sand and algæ: One mature male.

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ABBREVIATIONS

S. A. E. = Swedish "Antarctic" Expedition, 1901-03.
S. M. E. = Swedish Magellan Expedition, 1896.

Plate I.

Fig. 1. *Cythereis (Procythereis) torquata*, n. sp., ♀, not type. Tierra del Fuego, Cape Valentyn. ×62.

Fig. 2. *Cythereis (Procythereis) iganderssoni*, n. sp., ♀, not type. Tierra del Fuego, Cape Valentyn. ×69.

Fig. 3. *Cythereis (Procythereis) robusta*, n. sp., ♀, type. S. A. E., station 28. ×70.

Fig. 4. *Cythereis (Procythereis) radiata*, n. sp., ♀, not type. Tierra del Fuego, Borja Bay. ×77.

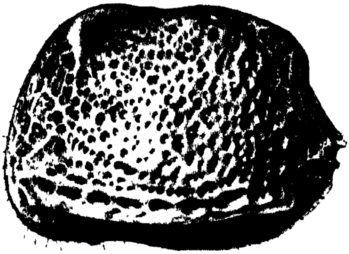
Fig. 5. *Cythereis (Procythereis) polita*, n. sp., ♂, type. Tierra del Fuego, no definite locality. ×91.

Fig. 6. *Cythereis (Cythereis) tæniata*, n. sp., ♀, not type. S. A. E., station 46. ×117.

Fig. 7. *Cythereis (Cythereis) tæniata*, n. sp. var. *deliciosa* n. var., ♀, type. Tierra del Fuego, Puerto Harris. ×87.

Fig. 8. *Cythereis (Cythereis) longiductus*, n. sp., ♂, not type. S. A. E., station 25. ×83.

[Fig. 6 drawn by Mr. G. Liljevall; the remaining figs. are photographs retouched by Mr. Liljevall.]



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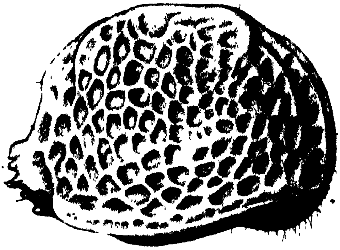

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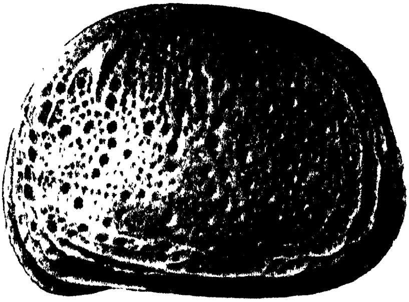

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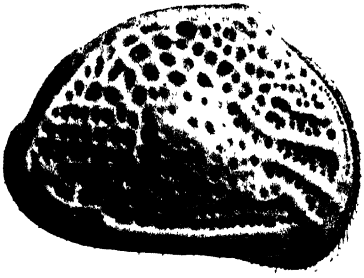

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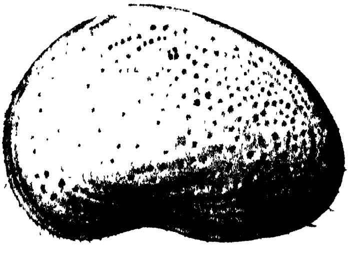

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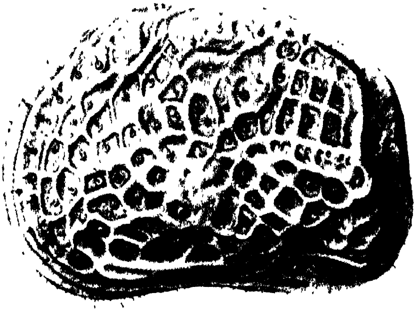

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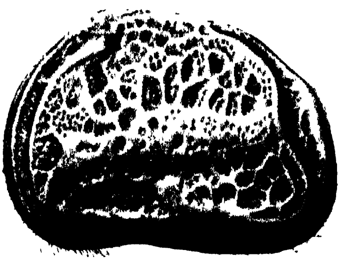

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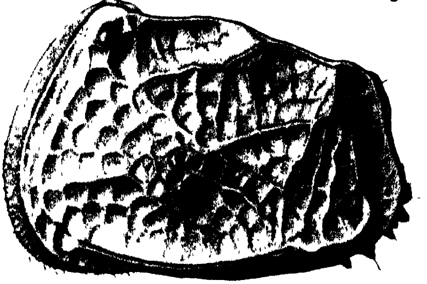

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PLATE II.

Fig. 1. *Cythereis* (*Cythereis*) *discophora*, n. sp., ♀, not type. S. A. E., station 46. ×109.

Fig. 2. *Cythereis* (*Cythereis*) *mesodiscus*, n. sp., ♂, not type. Tierra del Fuego, Isla Nueva. ×83.

Fig. 3. *Cythereis* (*Cythereis*) *mesodiscus*, n. sp., [illegible], not type. Tierra del Fuego, Chubut, Puerto Madryn. ×87.

Fig. 4. *Cythereis* (*Cythereis*) *megalodiscus*, n. sp., ♂, not type. S. A. E., station 25. ×90.

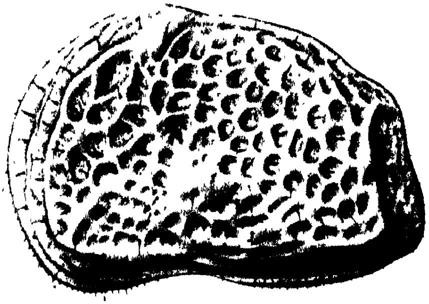
Fig. 5. *Cythereis* (*Cythereis*) *frequens*, n. sp., ♀, not type. S. A. E., station 25. ×67.

Fig. 6. *Cythereis* (*Cythereis*) *theeli*, n. sp., [illegible], not type. Tierra del Fuego, Chubut. ×85.

Fig. 7. *Cythereis* (*Cythereis*) *ephippiata*, n. sp., ♀, not type. S. A. E., station 46. ×94.

Fig. 8. *Cythereis* (*Pseudocythereis*) *spinifera*, n. sp., ♂, type. S. A. E., station 24. ×67.

(Figs. 1, 7 drawn by Mr. G. Liljevall, the remaining figs. are photographs retouched by Mr. Liljevall.)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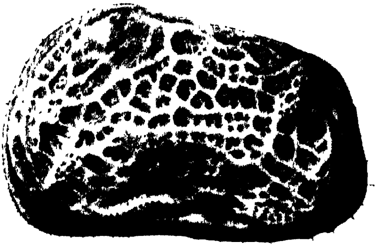
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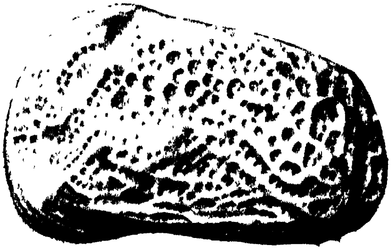
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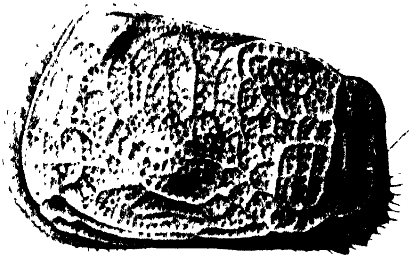
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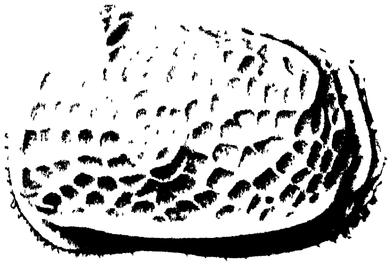
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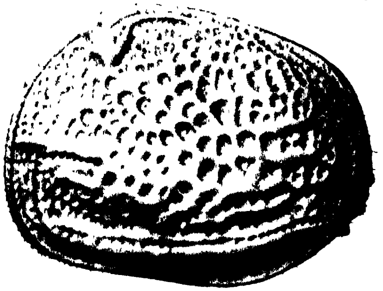
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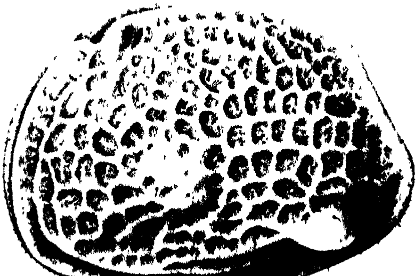
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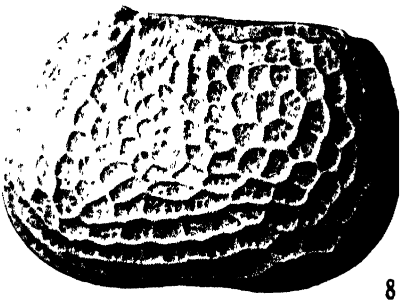
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PLATE III.

Fig. 1. *Cythereis* (*Cythereis*) ***pacifica***, n sp., ♂, not type. Slightly too elongated. California, Carmel Bay. ×127.

Fig. 2. *Cythereis* (*Cythereis*) ***glauca***, n. sp., ♀, not type. California, Carmel Bay. ×116.

Fig. 3. *Cythereis* (*Cythereis*) ***ephippiata***, n. sp , ♀, not type. Sculpture of the surface of the shell, somewhat behind the middle. S. A. E , station 46. ×300.

Fig. 4. *Cythereis* (*Cythereis*) ***montereyensis***, n sp., ♀, not type. Upper lip seen from in front; dorsal side up. California, Carmel Bay. ×400

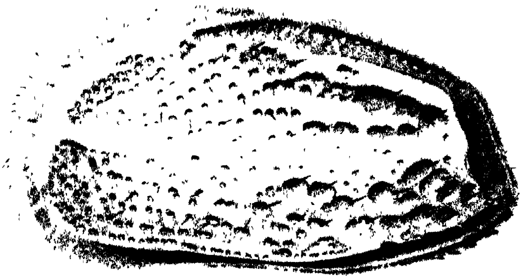
Fig. 5 *Cythereis* (*Cythereis*) ***montereyensis***, n. sp., ♀, not type. Upper lip seen from the left side; dorsal side up; line at the bottom indicates dorsal edge of lower lip. California, Carmel Bay. ×400.

Fig. 6 *Cythereis* (*Cythereis*) ***glauca***, n. sp , ♀, not type. Shell seen from above. Anterior end up. California, Carmel Bay. ×94.

Fig. 7. *Cythereis* (*Cythereis*) ***glauca***, n. sp., ♀, not type. Shell from below. Anterior end up. California, Carmel Bay. ×94.

Fig. 8. *Cythereis* (*Cythereis*) ***montereyensis***, n. sp., ♀, not type Postero-ventral portion of the left valve. California, Carmel Bay. ×230

[All drawings made by the author.]



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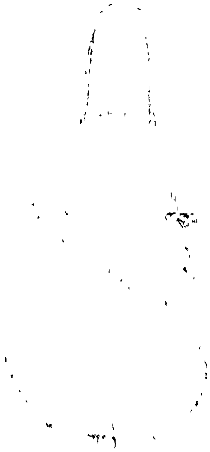

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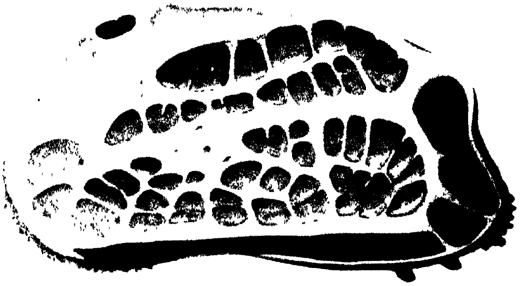

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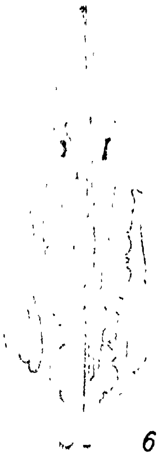

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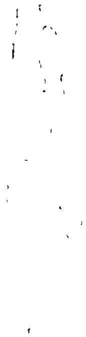

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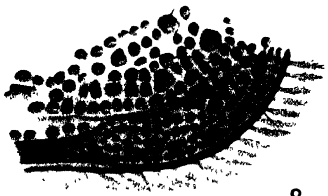

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Plate IV

Fig. 1. *Cythereis* (*Cythereis*) *recurvirostra*, n. sp., ♂, type. Right shell from the side. Note the selvage along the postero-ventral margin. S. A. E., station 59. ×82.

Fig. 2. *Cythereis* (*Procythereis*) *torquata*, n. sp., type. Penis. Tierra del Fuego, Puerto Condor. ×140.

Fig. 3. *Cythereis* (*Procythereis*) *radia*, n. sp., type. Left penis from outside. Tierra del Fuego, Borja Bay. ×220.

Fig. 4. *Cythereis* (*Procythereis*) *polita*, n. sp., type. Right penis from outside. Tierra del Fuego, no definite locality. ×240.

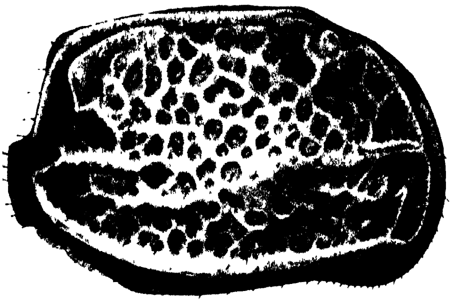
Fig. 5. *Cythereis* (*Cythereis*) *taeniata*, n. sp., not type. Left penis from outside. S. A. E., station 46, Falkland Islands. ×220.

Fig. 6. *Cythereis* (*Cythereis*) *longiductus*, n. sp., not type. Penis. S. A. E., station 25, S. Georgia. ×205.

Fig. 7. *Cythereis* (*Cythereis*) *mesodiscus*, n. sp., not type. Penis. Tierra del Fuego, Isle Nueva. ×200.

Fig. 8. *Cythereis* (*Cythereis*) *megalodiscus*, n. sp., not type. Penis. S. A. E., station 25, S. Georgia. ×250.

[Fig. 1 drawn by Mr. G. Liljevall. The remaining figs. are photographs of which figs. 2-5, 7 were retouched by Mr. Liljevall, the others by the author.]



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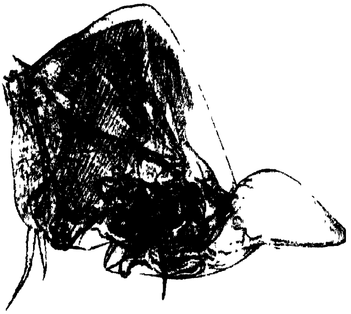

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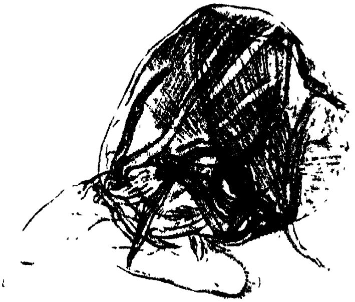

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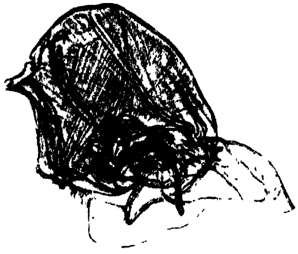

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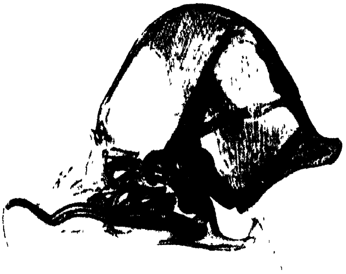

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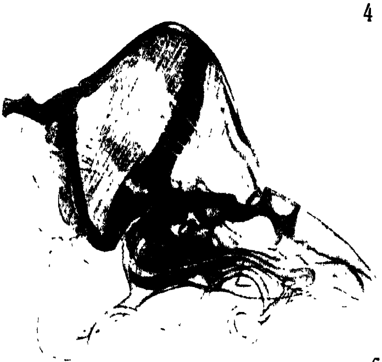

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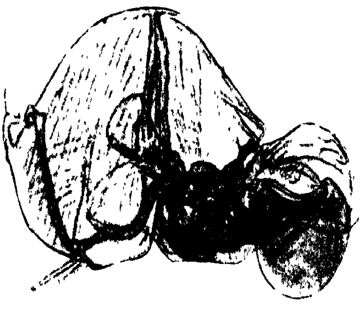

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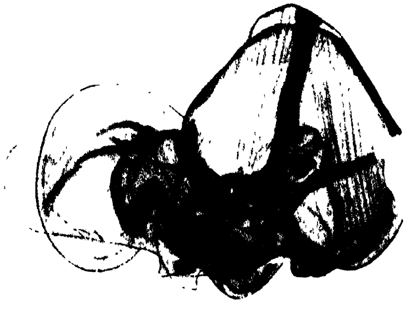

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Plate V.

Fig. 1. *Cythereis* (*Cythereis*) *frequens*, n. sp., not type. Right penis from outside. S. A. E., station 25, S. Georgia. ×145.

Fig. 2 *Cythereis* (*Cythereis*) *ephippiata*, n. sp., not type Left penis from medial side. S. A. E., station 46, Falkland Islands. ×150.

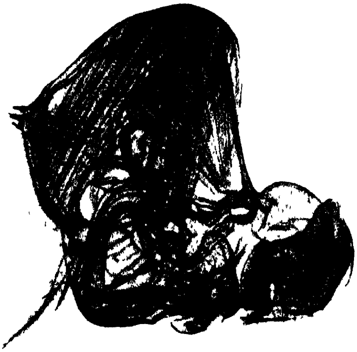
Fig. 3. *Cythereis* (*Cythereis*) *théeli*, n. sp., not type. Right penis from outside. Tierra del Fuego, Chubut. ×170

Fig 4 *Cythereis* (*Cythereis*) *recurvirostra*, n. sp., type. Penis S. A. E., station 59. ×160.

Fig. 5. *Cythereis* (*Pseudocythereis*) *spinifera*, n. sp., type. Penis. S. A. E., station 24, S. Georgia. ×130.

Fig. 6. *Cythereis* (*Pseudocythereis*) *falcata*, n. sp., type. Penis. S. A. E., station 28, S. Georgia. ×280

[All figs. are photographs, of which figs. 1-5 were retouched by Mr. G. Liljevall, fig. 6 by the author.]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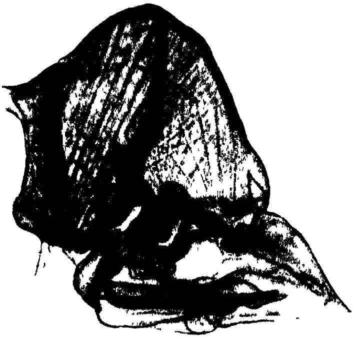
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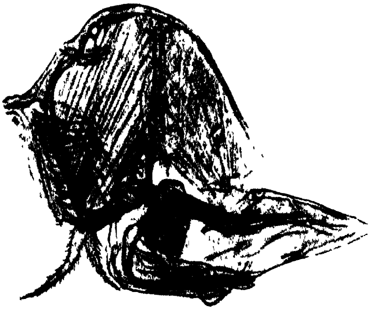
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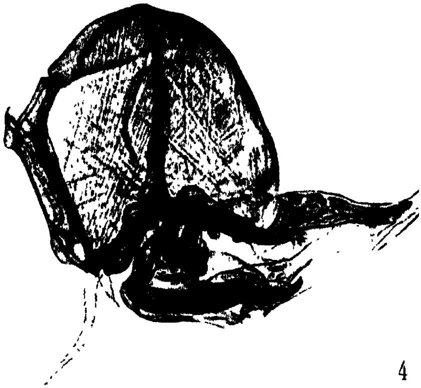
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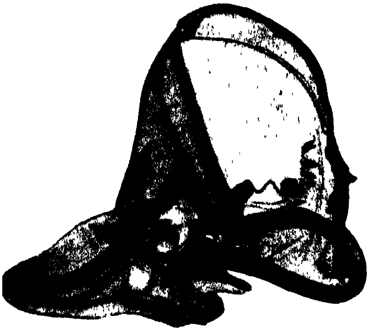
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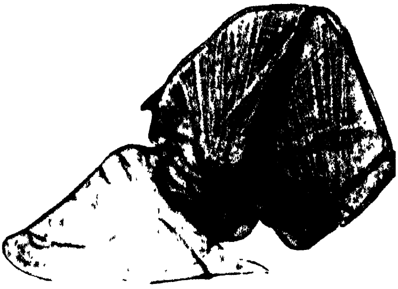
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Plate VI

Fig. 1. *Cythereis (Cythereis) montereyensis*, n. sp., type. Penis. Carmel Bay, California. ×143.

Fig. 2. *Cythereis (Cythereis) montereyensis*, n. sp., Penis of specimen 0.52 mm. long. Pacific Grove, California. ×143.

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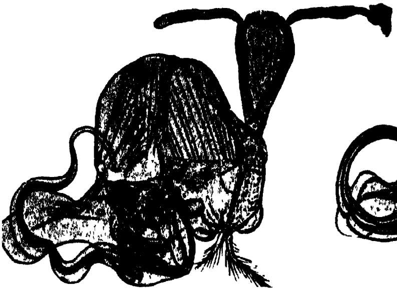
Fig. 4. *Cythereis (Cythereis) glauca*, n. sp., type. Penis. Carmel Bay, California. ×143.

Fig. 5. *Cythereis (Cythereis) aurita*, n. sp., not type. Left penis seen from the inner side. Pacific Grove, California. ×143.

Fig. 6. *Cythereis (Cythereis) aurita*, n. sp., not type. Right penis seen from the outside. Pacific Grove, California. ×143.

Fig. 7. *Cythereis (Cythereis) platycopa*, n. sp., type. Penis, erected. Pacific Grove, California. ×143.

[All figs. are photographs retouched by the author.



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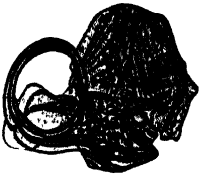

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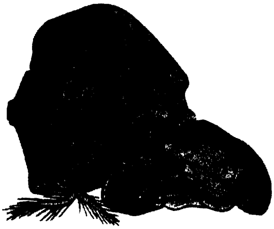

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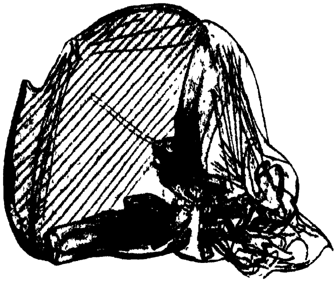

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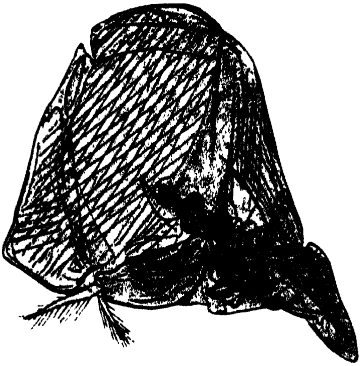

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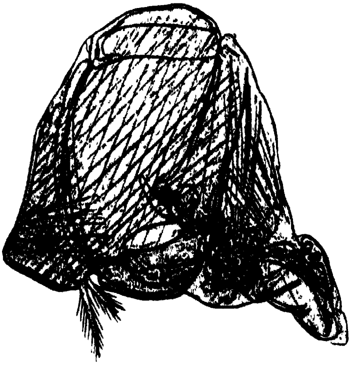

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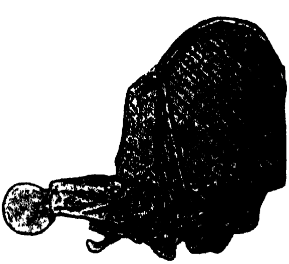

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Occasional Papers

OF THE

CALIFORNIA ACADEMY OF SCIENCES

XVI

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SAN FRANCISCO
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SEPTEMBER 15, 1928

THE AMPHIBIANS
OF
WESTERN NORTH AMERICA

An Account of the Species Known to Inhabit
CALIFORNIA
ALASKA, BRITISH COLUMBIA, WASHINGTON, OREGON
IDAHO, UTAH, NEVADA, ARIZONA, SONORA,
AND LOWER CALIFORNIA

BY
JOSEPH R. SLEVIN
Curator, Department of Herpetology

SAN FRANCISCO
CALIFORNIA ACADEMY OF SCIENCES
SEPTEMBER 15, 1928

To the memory of
JOHN VAN DENBURGH
a good friend and
my companion on many trips a-field

PREFACE

In its general character, the present work follows the plan of "The Reptiles of Western North America," by the late John Van Denburgh, published in 1922. It includes descriptions of the amphibians of the same geographical area, and thus completes the review of the herpetology of the western portion of our continent.

The illustrations as in the earlier volumes have been made from original photographs from living amphibians.

The untimely death of Dr. John Van Denburgh prevented his finishing this work, as he had planned, and therefore the author, his co-worker for many years, has brought it to completion.

As in "The Reptiles of Western North America," this study is based primarily on the collection of the California Academy of Sciences. Additional material was obtained from Stanford University Museum, the Museum of Vertebrate Zoology of the University of California, and the Provincial Museum, Victoria, British Columbia, in charge of Professor J. O. Snyder, Dr. Joseph Grinnell, and Mr. G. A. Hardy, respectively, to whom I am indebted for the use of collections and records. My thanks are extended to the following staff members of the California Academy of Sciences: Dr. Barton Warren Evermann, Director of the Museum, who made possible the publication of this volume; Dr. G. Dallas Hanna, Curator, Department of Invertebrate Paleontology, for assistance in photography; Mr. H. S. Swarth, Curator, and Miss Mary E. McLellan, Assistant Curator, Department of Ornithology and Mammalogy, for criticism of the manuscript; and Mr. Ignatius McGuire, Assistant Librarian. Thanks are due also to Mr. L. M. Klauber of the San Diego Zoological Society for help in many ways.

THE AUTHOR

San Francisco, California.

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THE AMPHIBIANS OF WESTERN NORTH AMERICA

INTRODUCTION

The amphibians form a group of vertebrates often popularly confused with the reptiles. The superficial resemblance between salamanders and lizards may be very great, yet such real differences exist between amphibians and reptiles that zoologists regard them as belonging to distinct classes, groups as different as mammals, birds and fishes. As Dr. Gadow says: "A Bird is known by its feathers, a Beast by its hairs, a Fish by its fins, but there is no such obvious feature which characterises the Amphibia and the Reptiles. In fact they are neither fish, flesh nor fowl."

Most amphibians lay their eggs in water, and the young, for a time, breathe by means of gills. After a metamorphosis, during which the gills and other larval characteristics disappear, the young assume the form and structure of the adults and leave the water to spend a greater or less portion of their lives on land. Reptiles never lay their eggs in water, and their young are hatched or born with the form and structure of their parents. The skin of our amphibians often is moist or slimy, and is not covered with scales. Many embryological and anatomical differences between amphibians and reptiles exist but need not be stated here.

SYNOPSIS OF CLASSES

a.—Anal opening longitudinal or round; skin smooth or warty. without scales; no claws.* (Frogs, toads, salamanders, newts, waterdogs, tadpoles, etc.) ....Amphibia.—p. 21

a¹.—Anal opening tranverse or round; skin furnished with scales (varying from large plates to minute granules); or, if skin smooth, tail and claws present and jaws without teeth. (Turtles, lizards, snakes, etc.) .... Reptilia.

The amphibians of western North America are not very numerous. They represent two orders, the tailed amphibians or Caudata, and the tailless amphibians or Salientia. The former includes the salamanders and newts or waterdogs, while to the latter belong the toads, tree-toads, frogs, etc. In the following pages, there are admitted to the fauna of the area under consideration 46 species and subspecies of amphibians, belonging to 15 genera, eight families, and two orders. Of these 22 are salamanders, and 24 are frogs, toads, etc.

---

*Tips of digits sometimes horny.

The following lists show, in a general way, the known distribution of the various species and subspecies.

DISTRIBUTION OF CALIFORNIA AMPHIBIANS

SPECIES AND SUBSPECIES	Sierra Nevada	Northern Coast	Valleys	Southern Coast	Desert	Islands
1. Triturus torosus	x	x	x	x		
2. Ambystoma macrodactylum	x					
3. Ambystoma tigrinum		x	x			
4. Ambystoma paroticum		x				
5. Dicamptodon ensatus		x				
6. Batrachoseps a. attenuatus	x	x		x		x
7. Batrachoseps a. major				x		
8. Batrachoseps a. pacificus						x
9. Batrachoseps a leucopus				x		
10. Plethodon elongatus		x				
11. Ensatina eschscholtzii		x		x		x
12. Ensatina croceater				x		
13. Aneides lugubris lugubris	x	x	x	x		
14. Aneides lugubris farallonensis						x
15. Aneides ferreus		x				
16. Aneides flavipunctatus		x				
17. Hydromantes platycephala	x					
18. Ascaphus truei		x				
19. Scaphiopus hammondii			x	x	x	
20. Bufo alvarius					x	
21. Bufo punctatus					x	
22. Bufo boreas boreas	x	x				
23. Bufo boreas halophilus	x	x	x	x	x	
24. Bufo canorus	x					
25. Bufo woodhousii					x	
26. Bufo cognatus cognatus					x	
27. Bufo cognatus californicus				x		
28. Hyla regilla	x	x	x	x	x	x
29. Hyla arenicolor				x	x	
30. Rana pipiens	x				x	
31. Rana pretiosa	x					x
32. Rana boylii boylii	x	x	x		x	x
33. Rana boylii sierræ	x					
34. Rana boylii muscosa				x		
35. Rana aurora draytonii		x	x	x		

Amphibians of Alaska:

1. Triturus torosus
2. Batrachoseps attenuatus caudatus
3. Bufo boreas boreas
4. Rana cantabrigensis

Amphibians of British Columbia:

1. Triturus torosus
2. Ambystoma macrodactylum
3. Ambystoma decorticatum
4. Ambystoma paroticum
5. Dicamptodon ensatus
6. Plethodon intermedius
7. Aneides ferreus (insular)
8. Bufo boreas boreas
9. Hyla regilla
10. Rana pretiosa
11. Rana aurora aurora
12. Rana cantabrigensis

Amphibians of Washington:

1. Triturus torosus
2. Ambystoma macrodactylum
3. Ambystoma tigrinum
4. Ambystoma paroticum
5. Dicamptodon ensatus
6. Rhyacotriton olympicus
7. Plethodon intermedius
8. Plethodon vandykei
9. Ensatina eschscholtzii
10. Ascaphus truei
11. Scaphiopus hammondii
12. Bufo boreas boreas
13. Hyla regilla
14. Rana pipiens
15. Rana pretiosa
16. Rana aurora aurora

Amphibians of Oregon:

1. Triturus torosus
2. Ambystoma macrodactylum

3. Ambystoma tigrinum
4. Ambystoma paroticum
5. Dicamptodon ensatus
6. Batrachoseps attenuatus attenuatus
7. Plethodon intermedius
8. Ensatina eschscholtzii
9. Aneides ferreus
10. Ascaphus truei
11. Scaphiopus hammondii
12. Bufo boreas boreas
13. Bufo woodhousii
14. Hyla regilla
15. Rana pipiens
16. Rana pretiosa
17. Rana boylii boylii
18. Rana aurora aurora

Amphibians of Idaho:

1. Ambystoma macrodactylum
2. Ambystoma tigrinum
3. Scaphiopus hammondii
4. Bufo boreas boreas
5. Bufo woodhousii
6. Pseudacris triseriata
7. Hyla regilla
8. Rana pipiens
9. Rana pretiosa
10. Rana catesbeiana

Amphibians of Utah:

1. Ambystoma tigrinum
2. Scaphiopus hammondii
3. Bufo punctatus
4. Bufo compactilis
5. Bufo boreas boreas
6. Bufo woodhousii
7. Bufo cognatus cognatus
8. Pseudacris triseriata
9. Hyla regilla
10. Hyla arenicolor

11. Rana pipiens
12. Rana onca
13. Rana pretiosa

Amphibians of Nevada:

1. Scaphiopus hammondii
2. Bufo compactilis
3. Bufo boreas boreas
4. Bufo boreas halophilus
5. Bufo woodhousii
6. Pseudacris triseriata
7. Hyla regilla
8. Rana pipiens
9. Rana onca
10. Rana pretiosa

Amphibians of Arizona:

1. Ambystoma tigrinum
2. Scaphiopus hammondii
3. Scaphiopus couchii
4. Bufo alvarius
5. Bufo punctatus
6. Bufo compactilis
7. Bufo woodhousii
8. Bufo cognatus cognatus
9. Pseudacris triseriata
10. Hyla arenicolor
11. Rana pipiens

Amphibians of Sonora:

1. Scaphiopus couchii
2. Bufo alvarius
3. Bufo punctatus
4. Bufo woodhousii
5. Hyla arenicolor
6. Rana pipiens

Amphibians of Lower California:

1. Triturus torosus
2. Batrachoseps attenuatus leucopus

3. Ensatina croceater
4. Scaphiopus hammondii
5. Scaphiopus couchii
6. Bufo punctatus
7. Bufo boreas halophilus
8. Hyla regilla
9. Hyla arenicolor
10. Rana aurora draytonii

No amphibians have been found on islands in the Gulf of California. Those which have been taken on the islands of the western coast of North America are shown in the following table:

Distribution of Amphibians on Islands of the Pacific Coast

Species and Subspecies	Sergief	Carmen	Swan	Admiralty	Heceta	Annette	Dall	Queen Charlotte	Bayne	Denman	Gabriola	Vancouver	Castle Rock	Whale Rock	South Farallon	San Miguel	Santa Rosa	Santa Cruz	Santa Catalina	Los Coronados	Cerros
Titurus torosus		x		x			x					x									
Ambystoma paroticum												x									
Batrachoseps a. caudatus						x															
Batrachoseps a. attenuatus																			x	x	
Batrachoseps a. pacificus																x	x	x			
Plethodon intermedius												x									
Ensatina eschscholtzii													x	x							
Aneides lugubris lugubris																				x	
Aneides lugubris farallonensis															x						
Aneides ferreus									x	x	x										
Bufo boreas boreas			x	x	x			x				x									
Hyla regilla											x	x					x	x	x		x
Rana aurora aurora												x									
Rana pretiosa	x																				

BREEDING AND METAMORPHOSIS

Although most amphibians lay their eggs in water, certain species depart from this rule. In western North America, the salamanders of the genera Batrachoseps, Plethodon and Aneides deposit their eggs in moist places in holes or caves, or under stones, logs, boards, leaves or moss. Our other amphibians resort to the water to lay.

The number of eggs laid varies with the species and the individual, and may range from less than a dozen to several hundreds. The eggs are spherical and usually pigmented, at least above, except in the species of terrestrial habit. They usually are laid in small clusters (Triturus, Plethodon, Aneides, Hyla), large masses (Ambystoma, Rana), or in long strings (Bufo), and are surrounded by transparent gelatinous material. The size of the egg does not correspond with the size of the amphibian. The eggs which are not laid in the water are much larger than those that are.

The eggs soon develop into tadpoles or larvæ with gills and tails but no limbs. After a time, which may vary from two or three days to as many weeks, the larvæ of those species which deposit their eggs in the water escape from the gelatinous masses or membranes and become free-swimming. During the period of growth which follows, arms and legs develop simultaneously. In the Salientia the arms are hidden for some time within the gill chambers, and after they become external they remain much smaller than the hind limbs, while in the Caudata the arms and legs are about equally developed. After a period of days, weeks, or months, the aquatic larva undergoes a metamorphosis, during which it looses its gills and, in the case of the Salientia, its tail, and assumes the form, structure and coloring of the air-breathing adult.

In those species which lay their eggs on land, the larval stages of growth and the metamorphoses occur within the egg membranes, the young being hatched as small duplicates of their parents.

COLLECTING AND PRESERVING

Amphibians are usually found in moist places. Many species are nocturnal. The salamanders of the genera Triturus and Ambystoma often are found in springs, streams, ponds, or lakes. Other salamanders seem rarely if ever to go into water. Such are the species of Batrachoseps, Plethodon, and Aneides, which even lay their eggs on land. These salamanders usually are found in moist places, under stones, boards, logs, or moss, under the loose bark of trees or logs, in holes in trees or in the ground, or in caves, cellars or spring-houses. Some of our tailless amphibians, Bufo and Scaphiopus, live in very dry regions. They may be sometimes found at night but are most easily secured after rains, when they resort to ponds to lay their eggs. At these times they sometimes congregate in great numbers and large series may be secured. Most of the true frogs, Rana, are to be sought about the edges of streams, ponds and lakes.

Frogs are best collected with a .22 caliber pistol loaded with dust shot, or sometimes with a net, hook and line, or a pair of forceps. The other amphibians may be readily caught with the hands or with a small dip-net. All of the species are harmless.

Amphibians may be preserved in the same manner as reptiles except that strong alcohol should never be used, for the reason that it makes them dry, hard and brittle. Alcohol of 60 to 65 per cent preserves amphibians well. Care must be taken to have it enter the body cavity through a slit cut just to one side of the mid-ventral line. Amphibian eggs should be preserved in weak formalin.

The descriptions in the following pages are based upon alcoholic specimens unless otherwise stated. Living amphibians often are much more brightly colored. This is especially true of bright yellows, reds, and greens. Measurements are given in millimeters, from alcoholic specimens. The tail is measured from the anus. Limbs are measured from the side of the body to the tip of the longest toe.

Glossary of Terms as used in this Work

Adpressed.—Relating to limbs pressed tightly against the sides with toes facing one another.

Amphicœlous.—Vertebræ having the anterior and posterior surfaces of the centra concave.

Arciferous.—Relating to the pectoral arch of toads, where the precoracoid and coracoid are widely separated and connected by a large arched epicoracoid.

Areolated.—Divided into minute circular spaces.

Basibranchial.—The median ventral or basal skeletal portion of a branchial arch.

Canthus rostralis.—A ridge extending from the tip of the snout to the corner of the eye.

Carpus.—The wrist.

Ceratohyal.—The component of the hyoid arch next below the epihyal.

Choanæ.—Funnel-shaped openings, as the nasal passages.

Coccyx.—The part of the vertebral column beyond the sacrum.

Condyle.—A process on a bone for the purpose of articulation.

Coracoid.—A bone or process in the pectoral girdle.

Costal grooves.—Vertical grooves between the costal folds on the sides of the body in salamanders.

Cranial crests.—Horny ridges between the eyes on the heads of toads.

Dentigerous.—Bearing teeth.

Diapophyses.—The lateral or transverse processes of the neural arches of Anura.

Dorsal fin.—The median fin on the back of the tail of a salamander.

Edentulous.—Without teeth.

Ethmoid.—Bones which form a considerable part of the walls of the nasal cavity.

Eustachian tube.—A canal connecting the tympanic cavity with the pharynx.

Fenestra.—An opening in a bone or between two bones.

Fontanelle.—A gap or space between bones in the cranium closed only by membrane.

Fusiform.—Tapering gradually at both ends.

Internal nares.—Inner openings of the nasal passages.

Mandibular teeth.—Teeth in the lower jaw.

Maxillary teeth.—Teeth on the lateral bones of the upper jaw.

Metatarsal tubercle.—A horny raised surface on the metatarsus.

Nasolabial groove.—A groove extending between the nostril and the lip on certain salamanders.

Omosternum.—One of the elements of the amphibian sternum.

Opisthocœlous.—Vetrebræ having the centra concave behind.

Orbitosphenoid.—Paired cranial elements lying between presphenoid and frontal.

Osseous.—Composed of or resembling bone.

Palatine bones.—Bones supporting the posterior portions of the roof of the mouth.

Palmar tubercles.—Small rounded protuberances on the hands and feet of amphibians.

Parasphenoid teeth.—Teeth on the parasphenoid bone in the roof of the mouth of certain salamanders.

Parietals.—Paired bones of the roof of the skull.

Parotoid gland.—An enlarged gland situated on the side of the head.

Pedicel.—A short stem.

Phalanges.—The bones of the fingers and toes.

Pollex.—The thumb, or innermost digit of the normal five in the anterior limb.

Precoracoid.—An anterior ventral bone of the pectoral girdle of higher vertebrates.

Premaxillaries.—Paired bones anterior to the maxillary in most vertebrates.

Proötic.—The anterior bone of the otic capsule in vertebrates.

Pterygoid.—Wing-like process of the sphenoid bone.

Quadrate.—The bone with which the lower jaw articulates in birds, reptiles, amphibians, and fishes.

Sacrum.—The bone forming the termination of the vertebral column anterior to the coccyx.

Squamosal arch.—A membrane bone of the vertebrate skull forming part of the posterior side wall.

Stapes.—The innermost bone of the middle ear.

Sternum.—The breast-bone in vertebrates.

Subarticular tubercles.—Small protuberances on the under surfaces of the fingers and toes.

Tubercle.—A small protuberance.

Tympanum.—The drum-like cavity constituting the middle ear.

Urostyle.—An unsegmented bone, the posterior part of the vertebral column of anurous amphibians.

Vent.—The anus.

Vestibule.—A cavity leading into another cavity or passage, as the cavity of the ear-labyrinth.

Vomerine teeth.—Teeth on the vomers, situated in the anterior portion of the roof of the mouth.

Class AMPHIBIA

The amphibians of western North America belong to two groups, or orders, to which they may be referred by the following

SYNOPSIS OF ORDERS

a.—Body elongate, with well-developed tail; fore and hind limbs of nearly equal size...Caudata.—p. 21

a².—Body rather short and broad; no tail in adults (except male *Ascaphus*), hind limbs much longer than fore limbs...Salientia.—p. 78

Order I. CAUDATA

The order Caudata contains the tailed amphibians or salamanders. Those of western North America belong to three families.

SYNOPSIS OF FAMILIES

a.—No parasphenoid teeth.
  b.—Palatine teeth in two longitudinal series; skin often roughened with granular warts; costal grooves not evident...Salamandridæ.—p. 21
  b².—Palatine teeth transverse, sometimes converging posteriorly; skin smooth; costal grooves usually evident...Ambystomidæ.—p. 25
a².—Parasphenoid teeth present; skin smooth; costal grooves evident.......................................Plethodontidæ.—p. 40

Suborder I. MUTABILIA

Family I. SALAMANDRIDÆ

The members of this family have opisthocœlous vertebræ. Ethmoid wanting. Pterygoid present. Carpus and tarsus osseous. Palatines with posterior separate processes extending over the parasphenoid; bearing teeth on their inner margins. No dentigerous plates on the parasphenoid. Parietal entirely separated from prefrontals by broad frontals. No postfrontal-squamosal arch. Ceratohyal free, connected with the quadrate by ligament.

A single genus represents this family in western North America. The one species is amphibious in habit, but spends most of its time in the water. Its eggs are of small size, pigmented, and are deposited in small gelatinous masses usually attached to weeds growing in the water. The very small young soon emerge from these masses and loose their gills only after a long period of larval growth in the water.

Genus I. Triturus

Triturus Rafinesque, Anal, Nat., 1815, p. 78 (type, *cristatus*).

Triturus torosus (Eschscholtz)

Pacific Coast Newt

Plate I, figure 1

Triton torosus Eschscholtz, Zool. Atlas, Pt. 5, 1833, p. 12, pl. XXI, fig. 15 (type locality, central California probably near the coast, either at San Francisco or between San Rafael, Marin County, and Fort Ross, Sonoma County); Strauch, Mem. Acad. Imper. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 50.

Triton tereticauda Eschscholtz, Zool. Atlas, Pt. 5, 1833, p. 14 (type locality, Fort Ross, Sonoma County, California).

Triton Ermani Wiegmann, Erman's Reise um die Erde, Atlas, 1835, p. 24 (type locality, California); Wiegmann, Archive für Naturgeschichte, 2 Jahrg., II, 1836, pp. 163, 250.

Salamandra Beecheyi Gray, Zool. Beechey's Voyage, 1839, p. 99, pl. XXXI, fig. 3 (type locality, Monterey, California).

Salamandra (Triton) granulosa Skilton, Amer. Journ. Sci. & Arts, Ser. 2, VII, 1849, p. 202.

Notopthalmus torosus Baird, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, p. 284; Smith, The Tailed Amphibians including the Cæcilians, 1877, p. 105; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 130; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 7; Patch, Copeia, 1922, 111, p. 75; Breder, Copeia, 1923, No. 119, p. 75; Grinnell & Storer, Animal Life in the Yosemite, 1924, p. 651.

Taricha torosa Gray, Cat. Batrach. Grad. Brit. Mus., 1850, p. 25; Girard, U. S. Explor. Exped., Herpt., 1858, p. 5, pl. I, figs. 1-8.

Taricha lævis Baird & Girard, Proc. Acad. Nat. Sci. Phila., VI, 1853, p. 302 (type locality, San Francisco).

Diemyctylus torosa Cooper, *in* Cronise Nat. Wealth Calif., 1868, p. 486.

Triton lævis Strauch, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 50.

Diemyctylus torosus Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 28; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 160; Townsend, Proc. U. S. Nat. Mus., X, 1887, p. 241; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 204, pls. XXXVI, fig. 2, XXXVIII, figs. 1-4, XLV, fig. 8, XLIX, fig. 3; Cope, Proc. Acad. Nat. Sci. Phila., 1893, pp. 181, 183; Van Denburgh, Bull. U. S. Fish

Commiss. for 1894, p. 207; RITTER, Proc. Calif. Acad. Sci., Ser. 3, I, No. 2, 1897, p. 73, pl. III; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, p. 138; RUTHLING, Copeia, 1915, No. 25, p. 62; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 28.

Molge torosa BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 20.

Cynops torosus COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 23, 25, 28.

Ambystoma rubrum REID, Hist. Pasadena, 1895, p. 600 (type locality, probably vicinity of Pasadena, California).

Triturus torosus DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 450; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 3; PRATT, Verteb. Animals of the U. S. 1923, p. 154; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 44; KLAUBER, Zool. Soc. San Diego, Bull. No. 3, 1927, p. 1.

Description.—General form stout. Limbs well developed. Tail oval or cylindrical, and in the breeding season much compressed, with large ventral keel. Head depressed. Snout truncate when seen from above. overhanging in profile. Eyes moderate, separated anteriorly by about twice the length of the orbital slit. Nostrils small, opening laterally near corner of snout. Subnasal grooves not present. Line of lip curved strongly downward beginning at a point midway between the nostril and the orbit. Palatine teeth in two longitudinal rows converging between the inner margins of the nares. Parasphenoid teeth not present. Internal and external nares about equally distant. Tongue ovoid, free laterally, attached along median line. Neck rather short, about width of body. Costal grooves not evident. Anterior limbs with four and posterior with five digits. Digits depressed without terminal disk-like expansions; inner quite small, second and fourth nearly equal; second toe longer than fifth. Tail without constriction behind vent. Cloacal region enlarged. especially during the breeding season. When found in water during the breeding season has a smooth skin, sometimes with a few wrinkles.

The color above in alcohol is uniform dark brown or reddish-brown. The lower surfaces are orange or pale yellow. Both dorsal and ventral surfaces in rough skinned individuals are covered with minute reddish-brown horny points.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	78	72	71	76	73	76
Front of anus to end of tail	112	113	111	118	112	115
Width of head	17	16	16	16	17	17
Snout to orbit	5	5	5	4	5	5
Snout to fore limb	29	27	26	25	27	27
Axilla to groin	38	36	37	35	38	37
Fore limb	26	27	30	28	28	30
Hind limb	31	28	29	29	28	32
Breadth of hind foot	12	10	9	9	10	10

Distribution.—This species ranges along the Pacific Coast from Alaska south to northern Lower California.

In Alaska, it has been collected on Carmen, Admiralty and Dall islands, and at Hassler Harbor, Port Chester and Revillagigedo Harbor.

In British Columbia, it is known to occur on Vancouver Island as well as on the mainland, and has been taken at San Mateo Lake near Union Bay, Victoria, Metlakatla, Chilukiveyuk River, Fraser River, Bella Coola, Hagensborg, Ocean Falls, and Hatzic.

In Washington, it has been secured in Clallam (Neah Bay, Lapush, Forks), Jefferson (Bogachiel), King (Seattle), Pierce (Fort Steilacoom, Tacoma, Mount Rainier, Nesqually), Lewis (Skookumchuck Creek, Skookumchuck River near Chehalis), Pacific (Tokeland, South Bend, Ilwaco), Clark (Fort Vancouver), Kittitas (Easton), and Klickitat (Trout Lake, Goldendale) counties.

In Oregon, it has been found in Clatsop (Astoria, Gearheart, Olney), Tillamook (Garibaldi, Trask), Multnomah (Portland), Clackamas (Mount Hood), Yamhill (McMinnville), Lincoln (Newport, Toledo), Benton (Corvallis), Linn (The Lakes, Albany), Lane (Eugene, Cottage Grove, Mapleton), Douglas (Elkton, Drain, Deer Creek, Roseburg, Takeneitch Creek, Fort Umpqua), Coos (Empire, Myrtle Point), Curry (Port Orford, Harbor), and Klamath (Crater Lake), counties.

In California, it has been collected in Del Norte (Crescent City, Requa), Humboldt (three miles west from Arcata, Eureka, Carlotta, South Fork of Eel River at Myers ten miles below Phillipsville, White Thorn, Fair Oaks), Trinity (one-half mile south from Yollo Bolly Mountain, Gumboot Lake), Shasta (Castle Crags, Baird, McCloud River), Mendocino (near summit of Mount Sanhedrin, Sherwood six miles north from Willits, Willits, Mendocino City, Comptche, Albion River two miles below Comptche, Navarro River, Philo, Lake Leonard ten miles northwest from Ukiah, Ukiah, Alder Creek, Garcia River, Gualala, Fairbanks), Lake (Kelseyville), Sonoma (Warm Springs Creek near Skaggs Springs, Wheatville Fork of Gualala River, Fort Ross, six miles west from Cazadero, Knights Valley Creek near Kellogg, Monte Rio, mouth of Russian River, Camp Meeker, Freestone, Agua Caliente, Petaluma), Napa (Calistoga, Mount St. Helena, St. Helena, Berryessa Creek, Napa, Luscol), Marin (Inverness, Tocaloma, Tomales Bay, Camp Taylor, Lagunitas, Bolinas Bay, Mount Tamalpais, Muir Woods, Mill Valley, Phoenix Gulch, Kentfield, San Quentin, Sausalito, Point Bonita, Tennessee Cove), Solano (Vallejo), Contra Costa (Walnut Creek), Alameda (Moraga Valley, Berkeley, Oakland, Hayward), San Francisco (Golden Gate Park, Presidio), San Mateo (San Pedro Point, Tunitas Creek, San Mateo, Redwood City), Santa Clara (Palo Alto, Stanford University, Los Gatos), Santa Cruz (Santa Cruz, Brookdale), San Benito (San Juan), Monterey (Monterey, Pacific Grove, Carmel), San Luis Obispo (Santa Lucia Mountains), Placer (Auburn, Cisco), El Dorado (Fyffe), Calaveras (Mokelumne Hill), Mariposa (Pleasant Valley, Yosemite Valley), Madera (Northfork), Fresno (Fresno, Bear Creek), Tulare (Kaweah, Colony Mill, Redstone Park), Los Angeles (Millard and Fish canyons near Pasadena. Arroyo Seco Canyon, Pasadena, Big Santa Anita near Pasadena, Santa Anita Creek, Sierra Madre, Bailey Canyon. Sierra Madre, San Gabriel Mountains, West Fork San Gabriel River. San Dimas Canyon. Tropico, Winters Creek, Topango Canyon near Santa Monica, Las Flores and Rustic canyons in the Santa Monica Mountains), Orange (Trabuco Canyon), and San Diego (San Diego, San Diego River), counties.

Lower California specimens from San Andreas and Keller are in the U. S. National Museum.

Family II. AMBYSTOMIDÆ

The vertebræ are amphicœlus. Ethmoid wanting. Pterygoid present. Carpus and tarsus osseous. Palatine bones not extending over parasphenoid; bearing teeth on their posterior margins. No dentigerous plates on parasphenoid. Premaxillaries fully developed. Orbitosphenoid separated from proötic by membranous walls. Internal wall of vestibule osseous.

The members of this family lay their eggs in water. The young are small when hatched, and retain their gills through a long period of larval growth in lakes, ponds or streams. After transformation they become terrestrial and usually live a more or less subterranean existence.

SYNOPSIS OF GENERA

a.—Tongue attached along median line, lateral edges free.
  b.—Palatine teeth in long longitudinal series with narrow interspaces.... ....Ambystoma.—p. 26
  b^2.—Palatine teeth in short curved series.... ....Rhyacotriton.—p. 38
a^2.—Tongue adherent; palatine teeth in long longitudinal series with wide interspaces.... .... Dicamptodon.—p. 36

Genus 2. Ambystoma

Ambystoma **Tschudi**, Mem. Soc. Sci. Nat. Neuchatel, 1838, p. 92 type, *subviolacea*).

In this genus the parasphenoid teeth are absent. The tongue is adherent along the median line, with lateral edges free. The limbs are strong and well developed. There are five digits. The skin is smooth.

SYNOPSIS OF SPECIES

a.—Parotoid glands present.
  b.—Parotoid glands prominent: costal grooves ten, size large .... A. paroticum.—p. 26
  b^2.—Parotoid glands less prominent; costal grooves eleven or twelve; size moderate .... A. decorticatum.—p. 28
a^2.—Parotoid glands absent.
  bb.—Palatine teeth in three or four angular series; wide yellowish dorsal band .... A. macrodactylum.—p. 29
  bb^2.—Palatine teeth in a more or less straight line, extending across the roof of the mouth, sometimes with slight interspaces.... .... A. tigrinum.—p. 31

Ambystoma paroticum Baird

NORTHWESTERN SALAMANDER

Amblystoma paroticum **Baird**, Proc. Acad. Nat. Sci. Phila., 1867 (1868), p. 200 (type locality, Chiloweyuck, Washington Territory=[Chilliwack Lake, British Columbia]), **Strauch**, Mem. Acad. Impr. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 65; **Cope**, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; **Smith**, The Tailed Amphibians including the Cæcilians, 1877, p. 50; **Boulenger**, Cat. Batrach. Grad. Brit. Mus., 1882, p. 48, pl. II, fig. 3.

Chondrotus paroticus **Cope**. Amer. Naturalist, 1887, p. 88; **Cope**, Bull. U. S. Nat. Mus., No. 34, 1889, p. 105, fig. 21, pl. XXIV, figs. 6, 7; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 216.

Ambystoma paroticum GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 139; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 11; PATCH, Copeia, 1922, No. 111, p. 76; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 6; PRATT, Verteb. Animals of the U. S., 1923, p. 152; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 74; Copeia, 1926, No. 151, p. 111.

Description.—General form robust. Limbs strong and well developed. Parotoid gland prominent. Tail cylindroconical except distally. Head depressed, snout rounded, not overhanging in profile. Eyes small, separated anteriorly by one and one-half times the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by their distance from pupil. Line of lip not undulate. Vomerine teeth forming a nearly straight series just posterior to the inner nares. Tongue rounded, attached along median line, slightly free laterally. Neck short, a little narrower than width of body. Costal grooves ten, continued across belly. Anterior limbs with four and posterior with five digits. Digits moderate without terminal disk-like expansions. Tail without constriction behind vent: with well marked lateral grooves anteriorly. Skin roughened on dorsal and lateral surfaces. Under surfaces smooth.

Color in alcohol uniform dark brown above; under surfaces uniform gray or dark gray.

MEASUREMENTS OF A SPECIMEN IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	84
Front of anus to end of tail	95
Width of head	19.5
Snout to orbit	5
Snout to fore limb	33
Axilla to groin	39
Fore limb	33
Hind limb	37
Breadth of hind foot	17

Habits.—This species ranges from sea level to 8,000 feet. An adult was found in a little burrow it had excavated in wet earth under an old stump. Larvæ nearly ready to transform were taken in cold mountain streams at 8,000 feet on Mount Rainier, Washington.

Distribution.—This salamander ranges from British Columbia south along the coast to northwestern California.

In British Columbia it has been taken at Chilliwack Lake, Bella Coola, Hagensborg, and on Vancouver Island.

In Washington, it is known to occur in Clallam (Neah Bay, Lake Crescent), Jefferson (Hoh River near Spruce), Chehalis (Quiniault), Mason (Lake Cushman, Wildcat Lake, Skokomish River Valley), and Pierce (Mount Rainier), counties.

Oregon records are Seaside, Clatsop County, Hood River, and Three Sisters at 5,000 feet, and Butte Creek, Marion County.

In California it has been found near Requa, Del Norte County, and at Fair Oaks, Humboldt County.

Ambystoma decorticatum Cope

BRITISH COLUMBIA SALAMANDER

Amblystoma decorticatum COPE, Proc. Amer. Philos. Soc., 1886, p. 522 (type locality, **Port Simpson, British Columbia**).

Chondrotus decorticatus COPE, Amer. Naturalist, 1887, p. 88; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 107, fig. 22.

Ambystoma decorticatum STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 9; PRATT, Verteb. Animals of the U. S., 1923, p. 152; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 5.

Description.—Similar to *A. paroticum.* This species, known only from the type specimen. is described by Cope as being very close in character to *A. paroticum,* from which it differs in having less pronounced parotoid glands, a much shorter series of vomerine teeth, a more obtuse head, and in being smaller in size.

Ground color dark brown, with numerous white spots of irregular form and size on back, limbs, and tail. Under surfaces light brown.

MEASUREMENTS OF THE *TYPE* IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

Total length	174
Width of head	16
Fore limb	26
Hind limb	26

Distribution. This salamander has been recorded only from Port Simpson. British Columbia.

Ambystoma macrodactylum Baird

LONG-TOED SALAMANDER

Plate 1, figure 2

Ambystoma macrodactyla BAIRD, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, pp. 283, 292 (type locality, **Astoria, Oregon**); BAIRD, Rep. Pac. R. R. Surv., XII, Pt. II, 1860, pl. 31, fig. 3.

Amblystoma macrodactylum COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 198; STRAUCH, Mem. Acad. Impr. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 65; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 43; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 48; COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 23; YARROW, Bull. U. S. Nat. Mus., No. 34, 1889, p. 95, fig. 17, pl. XXV, fig. 6; COPE, Proc. Acad. Nat. Sci. Phila., 1893, pp. 181, 184.

Ambystoma macrodactylum HALLOWELL, Journ. Acad. Nat. Sci. Phila., III, Pt. 1, 1858, p. 354; COOPER, *in* Cronise, Nat. Wealth of Calif., 1868, p. 486; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 215; GRINNELL & CAMP, Univ. Calif. Publ. Zool. XVII, No. 10, 1917, p. 138; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 10; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 10; DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 458; BLANCHARD, Copeia, 1921, No. 90, p. 5; PATCH, Copeia, 1922, No. 111, p. 75; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 5; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 71.

Amblystoma epixanthum COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 16 (type locality, **swamp near the head of the South Boise River, south side of the Sawtooth Mountain Range, Idaho**); COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 97, fig. 18, pl. XXV, fig. 8.

Ambystoma epixanthum STEJNEGER, N. Amer. Fauna, No. 5, 1891, p. 111; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 9; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 11.

Aneides iecanus DICE, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 306, 309.

Description.—Limbs strong and well-developed, meeting when adpressed. No parotoid gland. Tail conical, flattened distally. Head depressed; snout oval, slightly overhanging in profile. Eyes small, separated anteriorly by one and one-half times the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by their distance from pupil. Line of lip straight. Vomerine teeth in an open v-shaped series starting at a point just posterior to the inner nares and meeting on the median line at a point opposite or just beyond the anterior point of the nares. Tongue thin, oval in outline, attached along the median line, slightly free laterally. Neck short, a little narrower than width of body. Costal folds normally eleven, not continued across belly. Anterior limbs with four and posterior with five digits. Digits long, without terminal disk-like expansions. Tail without constriction behind vent, with well-defined lateral grooves anteriorly. Cloacal region slightly enlarged. Skin smooth.

Color above in life black, or very dark brown. A wide rough-edged band of yellow extends from back of head to tip of tail. This band is sometimes broken and forms an irregular series of blotches. Top of head uniform black or blotched with yellow. Lateral and under surfaces brownish, speckled with small white dots on belly and gular region. In alcohol the yellow dorsal markings turn to a rich slate color.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	49	48	55	60	59	58
Front of anus to end of tail	44	42	51	55	65	43
Width of head	9	10	9	10	11	10
Snout to orbit	4	2	2	3	3	3
Snout to gular fold	11	17	13	14	14	13
Snout to fore limb	17	36	18	19	20	18
Gular fold to anus	35	27	42	46	45	45
Axilla to groin	21	15	27	32	35	35
Fore limb	15	17	15	15	16	16
Hind limb	16	8	18	19	22	18
Heel to end of longest toe	9	6	8	10	11	9
Breadth of foot	6		8	8	9	6

Habits.—At Payette Lake, Boise County, Idaho, this salamander was found under the loose bark of fallen trees. At Crater Lake, Klamath County, Oregon, in the latter part of June, it was an abundant species on the shores of the lake, where as many as four or five were found under a single small stone, close to the water's edge.

Distribution.—This salamander ranges from British Columbia south to central California and eastward across Idaho to Montana.

In British Columbia, it has been found on the North Fork of Moose River, and at Chilliwak Lake, Hatzic, Sawmill Lake (near Telegraph Creek), New Westminster, Hagensborg, Bella Coola, Clinton, and Watson Lake about 45 miles north of Clinton.

In Idaho, it has been secured in Boise (Lardo, McCall, Payette Lake) and Camas (Sawtooth Lake or Swamp near the head of

South Boise River on the south side of the Sawtooth Mountain Range), counties.

In Washington, it has been collected in Clallam (Port Angeles, Neah Bay), Kitsap (Gorse Creek), Chehalis (Hoquiam), Snohomish (Suiattle River, Monroe), Pierce (Paradise Valley, Mount Rainier), Chelan (Entiat River), Stevens (Springdale), Spokane (Cheney), Lincoln (Odessa), Whitman (Pullman), Walla Walla (Walla Walla, Prescott), and Columbia (Blue Mountains), counties.

Oregon records are from Clatsop (Astoria), Klamath (Crater Lake, Fort Klamath), Union (La Grande), and Wallowa (Wallowa Lake), counties, and the Strawberry Mountains, Des Chutes River, and the Willamette Valley between Salem and Portland.

In California, this salamander has been taken in Siskiyou (near Medicine Lake at 6,500 feet), El Dorado (Fallen Leaf Lake) and Calaveras (Mokelumne Hill), counties.

Ambystoma tigrinum (Green)

TIGER SALAMANDER

Plate 2

Salamandra tigrina GREEN, Journ. Acad. Nat. Sci. Phila., V, 1825, p. 116, pl. 25, fig. 7 (type locality, near **Moorestown, New Jersey**); HARLAN, Journ. Acad. Nat. Sci. Phila., V, 1827, p. 328; HARLAN, Med. & Phys. Research, 1835, p. 93; HOLBROOK, N. Amer. Herpetology, ed. 1, III, 1838, p. 109, pl. 25.

Salamandra ingens GREEN, Journ. Acad. Nat. Sci. Phila., VI, 1831, p. 254 (type locality, **New Orleans**).

Salamandra lurida SAGER, Amer. Journ. Sci. & Arts, XXXVI, 1839, p. 322 (type locality, **Detroit, Michigan**).

Triton tigrinus HOLBROOK, N. Amer. Herpetology, ed. 2, V, 1842, p. 79, pl. XXVI; DEKAY, Nat. Hist. New York, 1842, p. 83, pl. XV, fig. 32.

Triton ingens HOLBROOK, N. Amer. Herpetology, ed. 2, V, 1842, p. 85, pl. XXIX.

Ambystoma tigrina BAIRD, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, p. 284; DUMERIL & BIBRON, Erpetologie Générale, IX, 1854, p. 108.

Ambystoma malvortia BAIRD, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, pp. 284, 292 (type locality, **New Mexico**).

Ambystoma lurida BAIRD, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, p. 284.

Ambystoma episcopus BAIRD, Journ. Acad. Nat. Sci. Phila., Ser. 2, I, 1849, pp. 284, 293 (type locality, **Kemper County, Mississippi**).

Heterotriton ingens GRAY, Cat. Batrach. Grad. Brit. Mus., 1850, p. 33.

Xiphonura jeffersoniana GRAY, Cat. Batrach. Grad. Brit. Mus., 1850, p. 34.

Ambystoma tigrinum Gray, Cat. Batrach. Grad. Brit. Mus., 1850, p. 35; Hallowell, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 350; Smith, The Tailed Amphibians including the Cæcilians, 1877, p. 39; Elrod, The Museum, I, 1895, p. 263; Fowler, Ann. Rep. N. J. State Mus., 1906, p. 47; Strecker, Proc. Biol. Soc. Washington, XXI, 1908, p. 55; Hurter & Strecker, Trans. Acad. Sci. St. Louis, XVIII, No. 2, 1909, p. 18; Strecker, Baylor Bulletin, XII, No. 1, 1909, p. 9; Strecker, Baylor Univ. Bulletin, XIII, Nos. 4 & 5, 1910, p. 17; Strecker Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 81; Cockerell, Univ. Colorado Studies, VII, No. 2, 1910, p. 131; Hurter, Trans. Acad. Sci. St. Louis, XX, 1911, p. 73; Prosser, Univ. Colorado Studies, VIII, 1911, p. 257; Cary, N. Amer. Fauna, No. 33, 1911, pp. 22, 40; Thompson & Thompson, Ann. Rep. Board Geol. Surv. Michigan for 1911, Herpet., Michigan, 1912, p. 26; Ellis & Henderson, Univ. Colorado Studies, X, No. 2, 1913, pp. 49, 121; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, p. 392; Skinner, Copeia, 1914, No. 12, p. 3; Storer, Copeia, 1915, No. 24, p. 56; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 101; Strecker, Baylor Bulletin, XVIII, No. 4, 1915, p. 56; Ellis & Henderson, Univ. Colorado Bull., XV, No. 6, 1915, p. 253; Englehardt, Copeia, 1916, No. 30, p. 32; Englehardt, Copeia, 1916, No. 32, p. 48; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 138; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 12; Fowler & Dunn, Proc. Acad. Nat. Sci. Phila., 1917, p. 8; Dunn, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 457; Englehardt, Copeia, 1918, No. 60, p. 79; Ruthven, Occas. Papers Mus. Zool. Univ. Mich., No. 66, 1919, p. 2; Dunn, Proc. New England Zool. Club, VII, 1920, pp. 55, 58, 59; Pratt, Verteb. Animals of the U. S., 1923, p. 151; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 7; Strecker, Contrib. Baylor Univ. Mus., 1926, p. 4.

Ambystoma mavortium Gray, Cat. Batrach. Grad. Brit. Mus., 1850, p. 37.

Siredon lichenoides Baird, Proc. Acad. Nat. Sci. Phila., 1852, p. 68 (type locality, **lake at head of Santa Fe Creek, New Mexico**); Baird & Girard, Rep. Pac. R. R. Surv., X, 1859, p. 20, pl. XLIV, fig. 1.

Amblystoma proserpine Baird, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 173 (type locality, **Salado, four miles from San Antonio, Texas**); Baird, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 29, pl. XXXV, figs. 7-14.

Ambystoma nebulosum Hallowell, Proc. Acad. Nat. Sci. Phila., 1852, p. 209 (type locality, **New Mexico**); Hallowell, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 352 (locality, **San Francisco Mountains, New Mexico[=Arizona]**); Hallowell, Sitgreaves' Exp. Zuni & Colorado Rivers, 1853, p. 143, pl. XX.

Ambystoma californiense Gray, Proc. Zool. Soc. London, 1853, p. 11, pl. VII (type locality, **Monterey, California**).

Ambystoma fasciatum var., Duméril & Bibron, Erpetologie Générale, IX, 1854, p. 107, pl. CV, fig. 1.

Amblystoma californiense HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 355; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 42; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 60.

Ambystoma maculatum HALLOWELL, Proc. Acad. Nat. Sci. Phila., 1857, p. 215 (type locality, New Mexico); HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 355.

Desmiostoma maculatum SAGER, Peninsular Journ. Medicine, 1858, p. 428, fig. 1.

Ambystoma malvortium HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 352.

Ambystoma luridum HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 352.

Ambystoma ingens HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 353; COOPER, Rep. Pac. R. R. Surv., XII, Pt. II, 1860, pl. XXXI, figs. 2a-2f.

Ambystoma episcopum HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 354.

Ambystoma proserpine HALLOWELL, Journ. Acad. Nat. Sci. Phila., Ser. 2, III, 1858, p. 354.

Amblystoma mavortium BAIRD, Rep. Pac. R. R. Surv., X, 1859, Reptiles, p. 20; COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 184; STRAUCH, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 63; ALLEN, Proc. Boston Soc. Nat. Hist., XVII, 1874, p. 70; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 25; YARROW, Surv. W. 100th Merid., V, 1875, p. 516; COUES, Surv. W. 100th Merid., V, 1875, p. 631; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 149; COPE, Proc. Acad Nat. Sci. Phila., 1883, p. 14; CRAGIN, Trans. Kansas Acad. Sci., VII, 1906, p. 119.

Amblystoma californiense BAIRD, Rep. Pac. R. R. Surv., X, 1859, p. 12, pl. XXX, figs. 1-3; COOPER, Proc. Cal. Acad. Sci., IV, 1870, p. 64.

Siredon gracilis BAIRD, Rep. Pac. R. R. Surv., X, 1859, p. 13, pl. XLIV, fig. 2 (type locality, Cascade Mountains, near latitude 40°).

Camarataxis maculata COPE, Proc. Acad. Nat. Sci. Phila., 1859, p. 123.

Amblystoma? nebulosum COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 300.

Amblystoma tigrinum COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 179; STRAUCH, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 63; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 25; SMITH, Geol. Surv. Ohio, IV, 1882, p. 720; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 43; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 148; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 68, fig. 12, pl. XXV, fig. 7; STEJNEGER, N. Amer. Fauna, No. 3, 1890, p. 116; CRAGIN, Trans. Kansas Acad. Sci., VII, 1906, p. 119; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, p. 81; POWERS, Nebraska Univ. Studies, VII, 1907, p. 197; BOULENGER, Proc. Zool. Soc. London, 1913, p. 403, text-figs. 75, 76, pp. 406, 407; SURFACE, Zool. Bull. Penna. Dept. Agric., III, Nos. 3-4, 1913, p. 89.

Amblystoma obscurum Cope, Proc. Acad. Nat. Sci. Phila., 1867, p. 192; Strauch, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 63.

Amblystoma mavortium californiense Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 25; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 150, 192.

Siredon tigrina Velasco, La Naturaleza, IV, 1878, p. 209, pls. VII, VIII.

Amblystoma tigrinum californiense Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 86; Mearns, Bull. U. S. Nat. Mus., No. 56, 1907, p. 81; Storer, Copeia, 1915, No. 24, p. 56.

Amblystoma trisruptum Cope, Proc. Acad. Nat. Sci. Phila., 1867, p. 194 (type locality, **Ocate Creek**, on the **eastern side of the Sangre de Cristo Mountains, New Mexico**); Coues, Surv. W. 100th Merid., V, 1875, p. 633; Boulenger, Cat. Batrach. Grad. Brit. Mus., 1882, p. 45; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 150; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 86.

Distribution.—The Tiger Salamander is known to occur in many parts of the eastern United States and in Mexico. In western North America, it has been found in Washington, Oregon, Idaho, Utah, Arizona, and central California.

In California, it has been secured in Shasta (McCloud River), Humboldt (spring at 1,500 feet in the coast range), Sonoma (Petaluma), Sacramento (Galt), San Joaquin (Ripon, Stockton, Bellota), Contra Costa (Pacheco two miles west from Concord), Stanislaus (La Grange), Alameda (Oakland), Santa Clara (Palo Alto, Mayfield, Stanford University, Mount Hamilton), San Benito (San Juan), Monterey (Monterey), Merced (Merced), Fresno (Fresno, Oleander), Kings (Kings River below Kingsburg) and Kern (Fort Tejon), counties.

In Oregon, Astoria, Portland, the Cascade Mountains at latitude 44°, and The Dalles, are represented by specimens in the U. S. National Museum.

In Washington, it has been collected at Medical Lake, Spokane County, and Colville, Stevens County.

In Idaho, it has been reported from only Jefferson (Market Lake), Oneida (Malad), and Bear Lake (Bear Lake, Deep Lakes, Bloomington Canyon), counties, and the Snake River.

In Utah, the Tiger Salamander has been collected in Washington (Oak Valley at 9,000 feet in the Kolob Plateau, Le Verkin Breaks at 8,000 feet), Iron (Duck Lake at 10,000 feet on the Markagunt Plateau), Garfield (Panquitch Lake), Beaver (Otter Lake at 10,000 feet in the Tischar Mountains), Utah (Utah Lake), Wasatch (Lake Solitude at about 9,000 feet), Salt Lake (Fort Douglas), and Davis (Kaysville), counties.

Arizona specimens have been taken at Flagstaff, San Francisco Mountains, Prescott, Long Lake, White Mountains, Bonito Canyon, and "Southern Arizona".

Description.—General form moderately large. Limbs strong and well-developed. No parotoid gland. Tail cylindro-conical, flattened distally. Head depressed, snout rounded, not overhanging in profile. A very distinct gular fold. Eyes small, separated anteriorly by one and one-half times the length of the orbital slit. A prominent dorsal groove reaching from back of head to base of tail. Nostrils small, opening laterally near corners of snout, separated by a little more than their distance from pupil. Line of lip not undulate. Vomerine teeth posterior to and extending to the outer ends of the nares, forming a nearly straight series meeting at a slight angle medially and extending to a point slightly forward of the anterior ends of the inner nares. Tongue rounded, attached along median line, slightly free laterally. Neck short, a little narrower than width of body. Costal grooves twelve to fifteen, normally thirteen. Anterior limbs with four and posterior with five digits. Digits moderate, without terminal disk-like expansions. Tail without constriction behind vent, with well-marked lateral grooves anteriorly. Cloacal region much swollen. Skin smooth, but covered with the mouths of small glands on dorsal and lateral surfaces.

Ground color black or bluish-black. Back, top of head, sides, top of limbs and ventral surfaces covered with large spots or blotches of straw-yellow.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	73	75	75	80	85	98
Front of anus to end of tail	62	102	72	79	87	97
Width of head	15	19	17	17	18	22
Snout to orbit	6	8	8	7	9	9
Snout to gular fold	18	23	18	21	22	26
Snout to fore limb	25	30	27	57	32	36
Gular fold to anus	55	52	57	59	63	72
Axilla to groin	35	40	37	39	38	47
Adpressed limbs overlap	7	13	11	10	16	14
Fore limb	22	26	26	25	29	31
Hind limb	25	34	29	27	31	36
Heel to end of longest toe	10	14	12	14	14	15
Breadth of foot	11	14	11	10	14	16

Remarks.—Recently transformed specimens taken at Salt Lake City, Utah, have the ground color brown, or greenish-brown, marbled with black. The sides and ventral surfaces are brown, marbled with black.

Habits.—Recently transformed individuals were taken in Lake Solitude, Wasatch Mountains, Utah, in the early part of July while snow was still on the ground. In San Benito County, California, one was found about a foot below the surface of the ground in a ground squirrel burrow.

Genus 3. Dicamptodon

Dicamptodon STRAUCH, Mem. Acad. Sci. St. Petersb., Ser. 7, XVI, 1870, p. 68 (type, *ensatus*).

In this genus the parasphenoid teeth and parotoid glands are absent. The tongue is adherent. The digits are comparatively short and the limbs well developed. The skin is smooth.

A single species is represented within the geographical limits of this work.

Dicamptodon ensatus (Eschscholtz)

PACIFIC GIANT SALAMANDER

Plate 3

Triton ensatus ESCHSCHOLTZ, Zoölogischer Atlas, Pt. 5, 1883, p. 6, pl. XXII (type locality, central California); VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 221.

Amblystoma tenebrosum BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 174 (type locality, Oregon); BAIRD, Rep. Pac. R. R. Surv., XII, 1860, Pt. II, pl. 31, fig. 1; COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 202; STRAUCH, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 65; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 45; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 49; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 152; COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 23; TOWNSEND, Proc. U. S. Nat. Mus., X, 1887, p. 240.

Xiphonura tenebrosa GIRARD, U. S. Explor. Exped., Herpet., 1858, p. 14, pl. I, figs. 9-17.

Dicamptodon ensatus STRAUCH, Mem. Acad. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 69; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 38; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 192; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p.

221; **STEJNEGER & BARBOUR**, Check List N. Amer. Amph. Rept. 1923, p. 7; **PRATT**, Verteb. Animals of the U. S., 1923, p. 149; **STORER**, Univ. Calif. Publ. Zool., XXVII, 1925, p. 77.

Chondrotus tenebrosus **COPE**, Amer. Naturalist, 1887, p. 88; **COPE**, Bull. U. S. Nat. Mus., No. 34, 1889, p. 111, fig. 24, pls. XXII, XXIII, XXIV, figs. 1-3.

Ambystoma ensatum **GRINNELL & CAMP**, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 139; **DUNN**, Proc. New England Zool. Club, VII, 1920, p. 55.

Ambystoma tenebrosum **STEJNEGER & BARBOUR**, Check List N. Amer. Amph. Rept., 1917, p. 11; **FOWLER & DUNN**, Proc. Acad. Nat. Sci. Phila., 1917, p. 11; **DUNN**, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 458.

Description.—General form robust. Limbs strong and well developed. Temporal regions in large specimens much swollen. A prominent dorsal groove reaching from back of head to base of tail. Tail cylindro-conical, compressed distally. Head broad, depressed, snout rounded, not overhanging in profile. Eyes very large and bulging, separated anteriorly by twice the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by their distance from pupil. Line of lip straight, with a sharp turn downwards at the terminus. Vomerine teeth in two undulate series posterior to the inner nares, touching on the median line with the apex turned backwards. Maxillary teeth prominent. Inner nares much closer than external. Tongue large, ovate, attached along the median line, slightly free laterally. Neck short, a little narrower than width of body. Costal grooves normally twelve. Anterior limbs with four and posterior with five digits. Digits short, depressed, with small terminal knobs. Skin smooth, or in large adults slightly roughened on lateral surfaces, pitted with the mouths of small glands.

Dorsal and lateral surfaces purplish-brown, mottled or reticulated with very dark brown or black. Belly and under surface of tail and digits a light brown or yellowish-white. Gular region a slightly lighter shade of the dorsal coloring reticulated with dark brown.

Distribution.—This large salamander ranges from British Columbia south along the coast to Monterey Bay, California.

In British Columbia, it has been reported from Sumas Lake and Chiloweyuck or Chilliwack Lake.

In Washington, it has been found on Puget Sound, and in King (Lake Washington, Soenic), Mason (Lake Cushman), Pierce (Mount Rainier), counties, and on Tye River.

In Oregon, it has been taken in Clatsop (Astoria), Tillamook (Tillamook), Lincoln (Yaquina), and Coos (Empire), counties. In California, it has been taken in Del Norte (Requa, Shallow Creek), Shasta (Lower McCloud River, Baird), Humboldt (Orick, Fair Oaks, Hoopa Valley), Mendocino (Mendocino City), Lake (Glenbrook, Allen Springs), Sonoma (Agua Caliente, Camp Meeker, Freestone), Napa (St. Helena, St. Helena Mountains), Marin (Tomales Bay, six miles west from Inverness, Big Carson Creek, Lagunitas, Fairfax, Muir Woods, Mill Valley, Paper Mill Canyon near San Geronimo, San Rafael. Sausalito, four miles west from Sausalito), Alameda (Berkeley), San Mateo (La Honda), Santa Clara (Stevens Creek Canyon, Saratoga, Los Gatos, Boulder), and Santa Cruz (Boulder Creek, Felton), counties.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	98	106	128	133	143	167
Front of anus to end of tail	76	80	107	113	107	137
Width of head	24	24	29	30	34	35
Snout to orbit	12	12	15	16	15	17
Snout to gular fold	27	27	36	38	39	43
Snout to fore limb	36	45	51	50	53	55
Gular fold to anus	71	79	92	95	104	124
Axilla to groin	50	50	62	68	60	87
Adpressed limbs overlap	11	14	14	6	8	6
Fore limb	27	28	33	37	34	37
Hind limb	37	37	45	44	48	48
Heel to end of longest toe	16	21	20	24	26	23
Breadth of foot	15	12	18	21	20	19

Habits.—This salamander is mostly found in the dampest parts of the dense redwood forests under large slabs of bark that have been partly embedded in the earth for a considerable period of time.

Remarks.—This species grows to a greater size than any other within the geographical limits of this work.

Genus 4. Rhyacotriton

Rhyacotriton DUNN, Proc. N. England Zool. Club, VII, 1920, p. 56 (type, *olympicus*).

In this genus the tongue is large with lateral borders free. The vomerine teeth are in two short series. The skin is smooth with lateral surfaces minutely pitted.

It is represented in North America by a single species.

Rhyacotriton olympicus (Gaige)

OLYMPIC SALAMANDER

Plate 4

Ranodon olympicus GAIGE, Occas. Papers Mus. Zool. Univ. Mich., No. 40, 1917, p. 2 (type locality, **Lake Cushman, Washington**); GAIGE, Occas. Papers Mus. Zool. Univ. Mich., No. 84, 1920, p. 2; STEJNEGER & BARBOUR, Check List N. Amph. Rept., 1917, p. 13; DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 456.

Rhyacotriton olympicus DUNN, Proc. New England Zool. Club., VII, 1920, p. 56; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 8; PRATT, Verteb. Animals of the U. S., 1923, p. 149.

Description.—Size small. Limbs short and well developed, failing to meet when adpressed. Tail cylindro-conical. Head slightly depressed. Snout rounded, not overhanging in profile. Eyes moderate, separated anteriorly by about twice the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by about the length of the orbital slit. Line of lip straight. Vomerine teeth in two short series, starting at a point just posterior to the internal nares, converging backward but not meeting on the median line. Tongue ovate, attached along median line, lateral borders slightly free. Neck about equal to width of body. A prominent mid-dorsal groove from back of head to base of tail. Parotoid gland present but not well developed. Fourteen costal grooves between limbs. Anterior limbs with four and posterior with five digits. Digits short, with small terminal knobs. Tail greatly compressed distally, with well defined lateral grooves near base. Skin smooth with minute pits on dorsal and lateral surfaces.

Color on dorsal surfaces and upper part of sides brownish or sepia brown. Under surfaces yellowish-white, gular region having a few small brownish spots. Sides of neck and lateral surfaces between limbs with a few scattered white dots.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	34	34	35	36	37	37
Front of anus to end of tail	25	24	26	24	26	25
Width of head	6	6	6	6	7	5
Snout to orbit	2	2	2	2	2	2
Snout to gular fold	8	8	9	8	9	8
Snout to fore limb	11	10	11	10	12	12
Gular fold to anus	26	26	26	26	28	29
Axilla to groin	20	19	19	19	21	21
Adpressed limbs fail to meet by	5	6	5	6	5	4
Fore limb	9	6	9	8	9	8
Hind limb	9	8	10	10	10	11
Heel to end of longest toe	4	5	5	4	4	4
Breadth of foot	4	5	4	4	5	5

Habits.—This salamander is apparently abundant in northwestern Washington, where the Academy's series was secured. It is usually found under stones and moss in the smaller streams.

Distribution.—This small species has been found only in northwestern Washington, where it has been taken in Clallam (five miles south from Forks), Jefferson (Hoh River near Fisher's ranch near Spruce), Chehalis (Quiniault), and Mason (Mount Ellinor, Lake Cushman, Mount Rose). counties.

Family III. PLETHODONTIDÆ.

Cope states the osteological characters of this family as follows: Vertebræ amphicœlous, simple below. Ethmoid wanting; no pterygoid. Carpus and tarsus cartilaginous. Vomeropalatine bones not produced posteriorly over parasphenoid; dentigerous plates on the parasphenoid. Ceratohyal undivided, articulating directly with the quadrate bone or cartilage; no otohyal. One only, the first epibranchial in adults; second basibranchial not connected with the first. Stapes not connected with the quadrate, by cartilage in adults. Vestibule, inner wall osseous (Bull. U. S. Nat. Mus., No. 34, 1889, p. 119).

This family includes most of our genera and species of salamanders. They are terrestrial in their mode of life and do not enter the water even to lay their eggs. The eggs are of very large size, without pigment, and are enclosed in gelatinous capsules. The young emerge from these capsules fully formed, but with small gills, which they quickly lose.

SYNOPSIS OF GENERA

a.—Tongue attached along median line forward to its anterior margin, free laterally and behind.
  b.—Hind foot with only four toes.. . ...Batrachoseps.—p. 41
  b'.—Hind foot with five toes.
    c.—Tail with strong basal constriction.
      bb.—No palmar tubercles.................. ...Plethodon.—p. 51
      bb'.—Palmar tubercles present. ....Ensatina.—p. 59
    c'.—Tail without basal constriction; one premaxillary bone; maxillary bone without teeth posteriorly, decurved, forming a cutting edge; anterior teeth large and few; line of lip turned strongly upward posteriorly in adults; temporal region often much swollen... ....Aneides.—p. 65
a'.—Tongue attached by a central pedicel only; free all around .. ..Hydromantes.—p. 76

Genus 5. Batrachoseps

Batrachoseps BONAPARTE, Fauna Italica, II, 1839, fol. 131 (type, *attenuatus*).

In this genus both vomerine and parasphenoid teeth are present. The teeth in the jaws are of normal size. The parietal bones are not completely ossified, leaving a large parietal fontanelle. The premaxillaries are united into a single bone. The tongue is attached along a median line, except posteriorly. Both anterior and posterior limbs are small and weak, and each has but four digits, the inner of which is rudimentary. The skin is smooth, pitted with the mouths of small glands which secrete a sticky mucus.

The few known species of this genus are all confined to western North America. One is known only from Alaska. The others are Californian, one of which, however, extends its range from Lower California and southern Oregon. These are terrestrial salamanders which often are found in considerable colonies under or in decaying wood in moist places. As the surface dries they probably burrow in the soil. The eggs are laid in damp situations. All the species are extremely elongate with very poorly developed limbs.

SYNOPSIS OF SPECIES AND SUBSPECIES

a.—Vomerine teeth in two separate series.
  b.—Costal grooves eighteen or more.

c.—Costal grooves twenty-one; tail excessively elongate. Alaska..**B. a. caudatus.**—p. 42

c^2.—Costal grooves eighteen to twenty; tail moderate in length; dorsal region dark; belly usually light brown. San Diego County, California, and Lower California ....**B. a. leucopus.**—p. 43

b^2.—Costal grooves usually seventeen; tail moderate in length: dorsal region lighter; belly usually yellowish. San Miguel, Santa Rosa, and Santa Cruz Islands..**B. a. pacificus.**—p. 45

a^2.—Vomerine teeth in a single patch.

bb.—Smaller; head narrower; tail longer; limbs shorter; color darker, especially on ventral surfaces which are gray, slate or blackish..**B. a. attenuatus.**—p. 47

bb^2.—Larger; head and tail robust; limbs longer; color paler, especially on ventral surfaces which are yellowish..**B. a. major.**—p. 50

Batrachoseps attenuatus caudatus Cope

ALASKA SALAMANDER

Batrachoseps caudatus COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 126, fig. 27, pl. LXXXI, fig. 2, (type locality, Hassler Harbor, Alaska, "Probably on Anette [=Annette] Island, S. E. Alaska", see Stejneger & Barbour); CAMP, Univ. Calif. Publ. Zool., XII, No. 12, 1915, p. 330; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 13; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 9.

Batrachoseps attenuatus caudatus DUNN, Smith College Anniv. Publs., 1926, p. 232.

Description.—General form elongate, slender. Body cylindric or somewhat flattened. Tail conical, a little less than twice the length of head and body. Head depressed, little broader than neck, rounded in outline from above. Snout rounded or truncate from above, truncate and high in profile. Eyes large and rather prominent, separated anteriorly by about the length of the orbital slit. Nostrils small, near corners of snout, separated by a little more than their distance from orbits. Upper jaw overhanging lower. Line of lip nearly straight. Vomerine teeth in two nearly straight very oblique series which nearly meet on the median line posteriorly, and anteriorly do not extend to the internal nares. Parasphenoid teeth separated into two distinct patches by a space which is broad posteriorly but narrow anteriorly; extending nearly to the vomerine series. Internal nares are rather small, in front of and a little external to the anterior ends of the vomerine teeth. Tongue large, oval, not emarginate, attached along the median line, free laterally and posteriorly. Neck not distinct from body, with several vertical and longitudinal grooves. Gular fold well marked. Costal grooves twenty-one, continued across belly but not visible on back. Limbs short, weak, each with four digits. Digits with rounded truncate ends, inner digit short, rudimental, others well developed, second and fourth nearly equal, third longest, web small or absent. Tail more slender than body, excessively elongate. A more or less distinct dorsal longitudinal groove. Skin smooth with minute pits. Adpressed limbs widely separated.

The general color is described by Cope as brown, deeper on the lateral regions to a line on each side of the back, and on the anterior half of the belly and on the upper surface of the distal part of the tail. The gular region and chin are yellowish.

MEASUREMENTS OF THE *Type* IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

Total length	160
Length to base of tail	57
Length of tail	103
Snout to axilla	11½
Snout to groin	51
Width of head	6
Fore limb	6½
Hind limb	7

Remarks.—This species is known only from the single type specimen. It is closely related to *B. a. attenuatus* but is said. by Cope. to differ in (1) having the parasphenoid teeth in two patches: (2) the absence of dorsal grooves: (3) the very elongate tail: (4) the longer patches of vomerine teeth.

Distribution.—The only known specimen is recorded by Cope as having been collected at Hassler Harbor. Alaska. Stejneger and Barbour state that it probably came from Annette Island, southeastern Alaska.

Batrachoseps attenuatus leucopus Dunn

CORONADOS ISLANDS SALAMANDER

Plate 5, figure 1

Batrachoseps attenuatus VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, IV, p. 139.

Batrachoseps leucopus DUNN, Copeia, No. 109, 1922, p. 61, (type locality, Los Coronados Islands, North Island, Lower California);

STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 9.

Batrachoseps attenuatus leucopus DUNN, Anniv. Publs. Smith College, 1926, p. 241; KLAUBER, Zool. Soc. San Diego, Bull. No. 3, 1927, p. 1.

Description.—General form elongate, slender. Body and tail cylindric or somewhat flattened. Tail equal to or very little longer than body. Head depressed, narrow, rounded in outline from above. Snout truncate from above, high in profile. Eyes prominent, separated anteriorly by a little more than the length of the orbital slit. Nostrils small, near corners of snout, separated by a little more than their distance from orbits. A very indistinct nasolabial groove, extending about half way or a little over half way to margin of lip. Upper jaw overhanging lower. Line of lip straight to posterior end of orbital slit, then deflected downward. Vomerine teeth in two series reaching almost to the internal nares. Parasphenoid teeth separated by a narrow space posteriorly but confluent anteriorly, extending nearly to the vomerine series. Tongue moderate, somewhat rounded, attached along the median line, free laterally and posteriorly. Neck not distinct from body, a longitudinal line reaching from eye to fore limb. Gular fold distinct. Costal grooves between limbs usually eighteen, continued nearly to midline on back and belly. Limbs short, weak. each with four digits. Digits with round knob-like ends, inner digits short, rudimental, others well developed, second and fourth equal. third longest, web small or absent. Tail more slender than body, well marked with lateral grooves. A more or less indistinct longitudinal groove, most distinct on neck and pelvic region. Skin smooth with minute pits. Adpressed limbs widely separated.

Color in alcoholic specimens above chestnut brown, the wide dorsal stripe being bordered by a narrow stripe of black or very dark brown. Lateral and under surfaces light brown, minutely spotted with white.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	37	37	37	37	38	40	44
Front of anus to end of tail	43	37	41	41	37	45	46
Width of head	4	5	5	5	5	5	5
Snout to orbit	1½	1½	1	1	1½	2	1
Snout to fore limb	10	11	10	10	10	10	11
Axilla to groin	24	24	23	23	25	25	29
Fore limb	5	5	6	6	5	6	6
Hind limb	6	6	6	6	6	6	6

Remarks.—There seems to have been some doubt as to the range of the southern form of *Batrachoseps* but on examining a series from the San Pedro Martir Mountains, Lower California, Mexico, it seems certain that the subspecies *leucopus* extends to that locality.

Habits.—In the San Pedro Martir Mountains this salamander was found under the bark of fallen trees. On the Coronados Islands it was found under stones.

Distribution.—To this southern form of *Batrachoseps* have been referred specimens recorded from Bonsall, Wildwood, Mussey, La Jolla, San Diego, Spring Valley, Cottonwood and Descanso, San Diego County, California.

From Lower California, specimens have been recorded from the San Pedro Martir Mountains and the Coronados Islands.

Batrachoseps attenuatus pacificus (Cope)

ISLAND SALAMANDER

Plate 5, figure 2

Hemidactylium pacificum COPE, Proc. Acad. Nat. Sci. Phila., 1865, p. 195 (type locality, **Santa Barbara, California** [probably one of the Channel Islands]).

Batrachoseps pacificus COPE, Proc. Acad. Nat. Sci. Phila., 1869, pp. 97, 98; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 80; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 59; YARROW, Bull. U. S. Nat. Mus., No. 24, 1882 (1883), p. 153 (part); COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 129 (part); VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, No. 1, 1905, pp. 3, 6, 11, pl. III, figs. 1-7; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, IV, 1914, pp. 132, 134, 135; CAMP, Univ. Calif. Publ. Zool., XII, No. 12, 1915, p. 330; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 136; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 13; DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 458; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 9; PRATT, Verteb. Animals of the U. S., 1923, p. 161; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 101.

Batrachoseps attenuatus pacificus, DUNN, Anniv. Publs. Smith College, 1926, p. 236.

Description.—General form elongate, slender. Body cylindric or somewhat flattened. Tail conical, a little longer than head and body. Head depressed, rather broad, nearly circular in outline from above. Snout rounded or truncate from above, truncate and high in profile. Eyes large and rather prominent, separated anteriorly by about the length of the orbital slit. Nostrils small, near corners of snout, separated by a little more than their distance from orbits. A very indistinct nasolabial groove, not extending to margin of lip. Upper jaw overhanging lower. Line of lip nearly straight to below eye, then deflected downward. Vomerine teeth in two nearly straight very oblique series which nearly meet on the median line posteriorly, and anteriorly do not extend to the internal nares. Parasphenoid teeth separated by a narrow space posteriorly but confluent anteriorly, extending nearly to the vomerine series. Internal nares rather small, in front of the anterior ends of the series of vomerine teeth. Tongue large, oval, not emarginate, attached along the median line, free laterally and posteriorly. Neck not distinct from body, with several vertical and two or three longitudinal grooves. Gular fold well marked, continued forward on side of neck to eye; one or two indistinct grooves anterior to gular fold. Costal grooves between limbs usually seventeen, occasionally sixteen or eighteen,[1] continued nearly to mid-line on back and belly. Limbs short, weak, each with four digits. Digits with rounded knob-like ends, inner digit short, rudimental, others well developed, second and fourth nearly equal, third longest, web small or absent. Tail more slender than body, with well marked lateral grooves. A more or less indistinct dorsal longitudinal groove, most distinct on neck and pelvic region. Skin smooth with minute pits. Adpressed limbs widely separated.

Color in alcoholic specimens above yellowish-brown, paler on head and limbs and often becoming fawn-color on tail. Upper lip and all lower surfaces white or dull yellow. Young are much darker than adults, with lower surfaces often minutely dotted with brown.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	25	36	49	52	52	56
Front of anus to end of tail	20	31	64	56	63	59
Width of head	3½	5	7	6½	7	8
Snout to orbit	2	2	3	3	3	3
Snout to fore limb	7	10	13	13	14	14
Axilla to groin	15	22	31	36	33	38
Fore limb	5	7	9	9	8½	9
Hind limb	5½	7½	9½	9½	9½	10

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[1] In fifty specimens the costal grooves are seventeen 40 times, sixteen 6 times, and eighteen 4 times.

Remarks.—One specimen has five toes on one hind foot.

Distribution.—This salamander seems to be confined to San Miguel, Santa Rosa and Santa Cruz islands, California. It is possible that it occurs also on the Ana Capa islands, but it has not yet been found there.

Habits.—This species doubtless burrows in the earth. It usually is found under sticks, stones, or lumps of earth in moist places. I have found it also under the loose bark of fallen trees.

Batrachoseps attenuatus attenuatus (Eschscholtz)

SLENDER SALAMANDER

Plate 5, figure 3

Salamandra attenuata ESCHSCHOLTZ, Zoölogischer Atlas, Pt. 5, 1833, p. 1, pl. XXI, figs. 1-4 (type locality, California).

Batrachoseps attenuatus GRAY, Cat. Batrach. Grad. Brit. Mus., 1850, p. 42; HALLOWELL, Journ. Acad. Nat. Sci. Phila., IV, 1858, p. 348; COOPER, Rep. Pac. R. R. Surv., XII, 1860, Zool., p. 8, pl. XXXI, fig. 5; COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 98; COOPER, Proc. Calif. Acad. Sci., IV, 1870, p. 64; STRAUCH, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 85; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 79; LOCKINGTON, Amer. Naturalist, XIV, 1880, p. 295; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 60; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 152; COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 28; COPE, Bull. U. S. Nat. Mus. No. 34, 1889, p. 127, fig. 28; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 560; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, No. 1, 1905, pp. 3, 16; BURKE, Amer. Naturalist, XLV, 1911, p. 413; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, IV, 1914, pp. 132, 137, 139; CAMP, Univ. Calif. Publ. Zool., XII, No. 12, 1915, p. 330; RUTHLING, Copeia, 1915, No. 25, p. 62; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 136; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 13; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 26; DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 459; STEPHENS, Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 59; NELSON, Mem. Nat. Acad. Sci., XVI, 1921, p. 113; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 615, 617, 620, 622, 632; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 8; Pratt, Verteb. Animals of the U. S., 1923, p. 160; GRINNELL & STORER, Animal Life in the Yosemite, 1923, p. 654; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 89.

Batrachoseps attenuatus attenuatus DUNN, Anniv. Publs. Smith College, 1926, p. 224.

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Batrachoseps nigriventris **Cope, Proc. Acad. Nat. Sci. Phila., 1869, p. 98 (type locality, Fort Tejon, Kern County, California); Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 26; Boulenger, Cat. Batrach. Grad. Brit. Mus., 1882, p. 60; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 153; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 129; Fowler & Dunn, Proc. Acad. Nat. Sci. Phila., 1917, p. 26.**

Batrachoseps pacificus **Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 129 (part).**

Batrachoseps catalinæ **Dunn, Copeia, No. 109, 1922, p. 62 (type locality, Santa Catalina Island, California).**

Batrachoseps attenuatus catalinæ **Dunn, Anniv. Publs. Smith College, 1926, p. 239; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 98.**

Description.—General form elongate, slender. Body and tail cylindric or somewhat flattened. Tail longer than body. Head depressed, narrow, oval in outline from above. Snout truncate from above, high in profile. Eyes moderately large, separated anteriorly by a little more than the length of the orbital slit. Nostrils small, near corners of snout, separated by a little more than their distance from orbits. A very indistinct nasolabial groove, extending about half way to margin of lip. Upper jaw overhanging lower. Line of lip straight to posterior end of orbital slit, then deflected downward. Vomerine teeth in an irregular patch reaching almost to the internal nares. Parasphenoid teeth separated by a narrow space posteriorly but confluent anteriorly, extending nearly to the vomerine patch. Internal nares small, in front of the anterior ends of the vomerine teeth. Tongue moderate, somewhat rounded, attached on median line, free laterally and posteriorly. Neck not distinct from body, a longitudinal groove reaching from the eye to the fore limb. Gular fold distinct. Costal grooves between limbs usually nineteen, occasionally twenty or twenty-one, continued nearly to midline on back and belly. Limbs short, weak, each with four digits. Digits with round knob-like ends, inner digits short, rudimental, others well developed, second and fourth equal, third longest, web small or absent. Tail more slender than body, well marked with lateral grooves. A more or less indistinct longitudinal groove, most distinct on neck and pelvic region. Skin smooth with minute pits. Adpressed limbs widely separated.

Color in alcohol above light chestnut brown becoming darker laterally, the wide dorsal stripe being bordered by a narrow line of dark brown or black. Under surfaces light brown, slate or blackish, minutely spotted with white.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	38	43	39	38	36½	43
Front of anus to end of tail	53	50	48	48	54	50
Width of head	4	5	4½	4½	4	4½
Snout to orbit	1½	1½	1½	1	1	1
Snout to fore limb	8½	10	9	8	8	10
Axilla to groin	25	28	27	25	25	28
Fore limb	5	4	5	5	5	5
Hind limb	5	5	6	6	6	6

Remarks.—I am unable to distinguish Dunn's *B. a. catalinæ* from *attenuatus. B.a. catalinæ* as described by Dunn has a dark dorsal surface and light sides, while *B. a. attenuatus* has a light dorsal surface and dark sides. Two specimens in the Academy's collection from Santa Catalina Island show the dorsal coloration to be lighter than that of the sides and I have seen specimens from Santa Catalina Island that agree perfectly in coloration with typical *attenuatus.*

Habits.—*Batrachoseps a. attenuatus* is one of the most abundant salamanders in California. It inhabits moist situations in the pine forests of the coastal belt, where it sometimes lives in large colonies. I have taken over fifty out of a single rotten pine log.

Distribution.—The known range of *Batrachoseps attenuatus attenuatus* extends from southern Oregon to San Diego County, California.

In Oregon it has been taken at Gold Beach and Harbor. Curry County.

In California, it is known to live in the coast region practically the entire length of the state, along the western slope of the Sierra Nevada, and at some points in the interior valleys. It has been collected in Del Norte (Smith River, Crescent City, Castle Rock, Whale Rock. Requa), Humboldt (three miles north from Orick. Trinidad. Arcata. Eureka. Carlotta, Alton. Elinor), Mendocino (Cahto, Mendocino, Comptche. Ukiah), Sonoma (Skaggs Springs. Freestone, Duncan Mills. Camp Meeker, Petaluma). Napa (Napa. Saint Helena). Marin (Inverness, six miles south from Inverness. Bolinas Bay, Tocaloma, Mount Tamalpais. Muir Woods, Phoenix Gulch, Mill Valley, Sausalito. Angel Island), San Francisco(Presidio, Sutro Heights. Golden Gate Park), San Mateo (Colma. San Pedro Point, Moss Beach, Tunitas Creek, San Andreas Lake, San

Mateo, Redwood City, Menlo Park), Santa Clara (Palo Alto, Stanford University, San Jose, Alum Rock Canyon, Los Gatos, Coyote), Santa Cruz (Big Trees, Ben Lomond, Brookdale, Santa Cruz), San Benito (San Juan, Hollister), Monterey (Monterey, Pacific Grove, Carmel, Pescadero Point, six miles northeast from Soledad), Santa Barbara (Santa Barbara), Alameda (Oakland, Berkeley, Albany, Moraga Valley, Strawberry Canyon), Contra Costa (Red Rock), Solano (Mare Island), Sacramento (Sacramento), El Dorado (American River and Middle Fork), Calaveras (Mokelumne Hill), Merced (Snelling), Madera (North Fork, Malumne Ridge at 3,000 feet), Fresno (Fresno, Kings River Canyon, Pitman Creek, Pine Ridge), Tulare (Colony Mill, Progress Spring, three miles south from Nelson), Kern (Tehachapi Mountains, Tejon Pass, Fort Tejon), Los Angeles (Sierra Madre, Millard's Canyon near Pasadena, Claremont, Covina, Sherman, South Pasadena, Los Angeles, three miles southeast from Lankershim, Rustic Canyon, Santa Monica Mountains, Santa Catalina Island), San Bernardino (San Bernardino), Orange (Laguna Beach), counties.

Batrachoseps attenuatus major Camp

GARDEN SALAMANDER

Batrachoseps major CAMP, Univ. Calif. Publ. Zool., XII, No. 12, 1915, p. 327 (type locality, town of Sierra Madre, 1000 feet altitude, Los Angeles County, California); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 136; BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 14; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 9; PRATT, Verteb. Animals of the U. S., 1923, p. 161; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 99.

Batrachoseps attenuatus major DUNN, Anniv. Publs. Smith College, 1926, p. 234.

Description.—General form elongate. Body cylindrical or somewhat flattened. Tail large and round, about one and one-third times the length of head and body. Snout rounded or truncate from above, truncate and high in profile. Eyes large, separated by the length of the orbital slit. Nostrils small, near the corners of the snout, separated by a little more than their distance from orbits. An indistinct nasolabial groove, not extending to margin of lip. Upper jaw overhanging lower. Line of lip straight to a point below the posterior end of the orbital slit, then deflected downward. Vomerine teeth in a somewhat irregular patch nearly reaching the internal nares. Parasphenoid teeth separated by a narrow space posteriorly but confluent anteriorly, extending nearly to the vomerine patch. Tongue large, oval, not emarginate, attached along the median line, free laterally and posteriorly. Neck not distinct from body, with three or four longitudinal grooves. Sometimes a broken lateral groove reaches from a point behind the orbit to the front limb. Gular fold more or less prominent. Costal grooves between limbs usually eighteen, occasionally twenty, continued nearly to mid-line on back and belly. Limbs short, weak, each with four digits. Digits with rounded knob-like ends, inner digit short, rudimental, others well developed, second longer than fourth, third longest, web small or absent. Anterior portion of tail sometimes larger than body, with well marked lateral grooves. A well defined dorsal longitudinal groove. Skin smooth with minute pits. Adpressed limbs widely separated.

Color in alcoholic specimens bluish-gray, becoming yellowish on the sides. Lower surfaces grayish-yellow.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	51	54	59	49	47	44
Front of anus to end of tail	81	75	81	71	62	48
Width of head	6	6	7	6	6	6
Snout to orbit	2	2	2	1½	2	1½
Snout to fore limb	11	12	14	13	11	10
Axilla to groin	34	37	40	33	32	28
Fore limb	8	8	8	8	8	7
Hind limb	9	10	9	9	9	8

Remarks.—This subspecies can readily be distinguished from the other forms of Batrachoseps by the large size of the anterior portion of the tail which is sometimes larger than the body.

Habits.—Camp[1] states that this salamander has been found in piles of damp lumber and in post-holes. The type was found under a broken piece of cement sidewalk.

Distribution.—To *Batrachoseps attenuatus major* have been referred specimens from Los Angeles (Sierra Madre at 1000 feet, Pasadena), and Riverside (Riverside) counties.

Genus 6. Plethodon

Plethodon TSCHUDI, Mem. Soc. Sci. Nat. Neuchatel, 1838, p. 92 (type, *glutinosus*).

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[1] Univ. Calif. Publ Zool., XII, No. 12, 1915, p. 329.

In the salamanders of this genus both vomerine and parasphenoid teeth are present; the teeth in the jaws are not unusually large; the skull is well ossified; a prefrontal bone is present; there is a large fontanelle between the spines of the two premaxillary bones; the tongue is attached along the median line except posteriorly; the anterior limb has four digits; the skin is smooth, pitted with the mouths of small glands which secrete a thick, tenacious mucus.

This genus contains numerous species, of which three occur within the geographical limits of this work. These species are terrestrial in habits and do not enter the water, not even to lay their eggs. The latter are large, usually unpigmented, are laid in moist situations under cover of wood, stones or leaves, and seem to receive more or less care from the parent salamander. The species vary considerably in size and slenderness.

SYNOPSIS OF SPECIES

a.—Parotoid glands absent. Toes without basal web.
  b.—Form less elongate; costal grooves thirteen to fifteen, usually fourteen; adpressed limbs separated by about five costal interspaces.................. P. intermedius.—p. 52
  b'.—Form more elongate; costal grooves sixteen; adpressed limbs separated by six or seven costal interspaces .... P. elongatus.—p. 55
a'.—Parotoid glands present. Toes with basal web. Form robust; dorsal stripe and tail yellow.. P. vandykei.—p. 57

Plethodon intermedius Baird

WESTERN RED-BACKED SALAMANDER

Plate 6

Plethodon intermedius BAIRD, Proc. Acad. Nat. Sci. Phila., 1857, p. 209 (type locality, Fort Tejon, California); COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 100; STRAUCH, Mem. Acad. Imper. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 72; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 27; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 68; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 57; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 154, 192; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 145, fig. 33; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 218; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 16; FOWLER & DUNN, Proc.

Acad. Nat. Sci. Phila., 1917, p. 25; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 11; PRATT, Verteb. Animals of the U. S., 1923, p. 159; DUNN, Anniv. Publs. Smith College, 1926, p. 154.

Plethodon crassulus COPE, Proc. Amer. Philos. Soc., XXIII, 1886, p. 521 (type locality, California); VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 219; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 25.

Description.—General form elongate and slender, body slightly depressed. Tail strongly compressed distally. Head depressed, a little broader than widest part of body. Snout broadly truncate from above, rounded in profile. Eyes moderate but rather prominent, separated anteriorly by nearly twice the length of the orbital slit. Nostrils small, near corners of snout, separated by about their distance from edge of pupil. A nasolabial groove descending nearly to margin of lip. Line of lip nearly straight, descending slightly below corner of snout. Vomerine teeth in two slightly curved series, beginning a little behind but not external to the internal nares, converging obliquely backward, and separated medially by a little more than one-half their distance from the parasphenoid teeth. Parasphenoid teeth in two patches, divided anteriorly merely by a groove but posteriorly slightly separated into two wings. Internal nares of moderate size. Tongue ovoid, very thin posteriorly, not emarginate, attached along the median line, free laterally and for a short distance behind. Neck nearly as wide as body, a strongly marked longitudinal groove running posteriorly from eye to, or nearly to, end of transverse gular fold and with branch descending to corner of mouth. No evident parotoid gland. A groove along vertebral line from head to base of tail. Costal grooves between limbs usually fourteen, occasionally thirteen or fifteen[1], not extending to midline of back but sometimes continued across belly. Limbs well developed but rather slender and delicate. Anterior limbs with four and posterior with five digits.

Digits slender and well developed, except inner which is short: third finger longest, second longer than fourth, second toe longer than fifth, third and fourth equal; no web, three phalanges of third and fourth toes free. Tail slender, strongly compressed in posterior two-thirds, with indefinite lateral grooves proximally. Skin shiny, but roughened on sides and tail. Adpressed limbs separated by about the distance between costal grooves.

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[1] In seventy-five specimens the costal grooves are fourteen 126 times, thirteen 23 times, and fifteen once.

The back may be unicolor, but usually a broad reddish band extends along the whole dorsal surface from snout to tip of tail, being broadest on back of head. In the larger alcoholic specimens, this band varies in color from blood-red to orange-vermilion, while in small specimens it is rufous. This reddish band is bordered laterally throughout its entire length by a narrow black stripe which fades gradually into the brown of the lateral regions. Lower part of sides and ventral surfaces of body and tail are minutely marbled with brown and yellowish-white, or in some specimens are blackish-brown. Limbs are similarly marbled except on upper surfaces of thigh and arm, which are light yellowish-red. Upper surface of head clouded with dark brown centrally, and close examination shows a considerable number of minute white dots scattered over its surface. Gular region yellowish-white clouded with brown. A few small brown markings are to be seen in the red dorsal band.

MEASUREMENTS OF 7 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	24	27	30	48	50	57	66
Front of anus to end of tail	17	19	40	49	48	53	71
Width of head	4	4	6	6	6	8	9
Nostril to orbit	1	1	2	2	2	2	2
Snout to orbit	2	2	3	3	3	4	4
Snout to gular fold	6	7	10	10	11	13	15
Snout to fore limb	7	8	13	13	14	17	18
Gular fold to anus	18	20	20	38	39	44	51
Axilla to groin	14	15	15	30	29	32	40
Adpressed limbs separated by	4	4	4	8	9	5	10
Fore limb	5	6	6	10	10	13	15
Hind limb	6	7	7	12	13	16	18
Heel to end of longest toe	2	2	2	5	5	7	8
Breadth of foot	1	1	2	3	3	4	4

Remarks.—This salamander was originally described from one specimen said to have been secured by John Xantus while stationed at Fort Tejon, California, but the records of the National Museum show that this locality probably is erroneous. In 1886, Cope described *Plethodon crassulus* from a specimen said to have been collected in "California" by Dr. J. G. Cooper. This name seems to have been based upon a specimen of *P. intermedius* which shows no dorsal band.

Distribution.—This salamander is common in British Columbia, Washington and western Oregon.

In British Columbia, it has been collected near the Fraser River and on Vancouver Island.

In Washington, it is common in the forest regions of the western part of the state and has been taken in Snohomish (Marysville, Monroe), King (Seattle), Jefferson (Hoh River near Spruce), Kitsap (Gorse Creek), Chehalis (Quiniault, Melbourne, Humptulips, Hoquiam, Montesano), Mason (Lake Cushman) and Pacific (South Bend), counties.

In Oregon, it is known from Clatsop (Olney), Multnomah (Portland) and Marion (Salem), counties.

Habits.—This slender salamander usually is found under wood or moss in moist places. A female collected near the Hoh River, Jefferson County, Washington, on September 20, 1919, contained eggs about two and one-half millimeters in diameter.

Plethodon elongatus Van Denburgh

DEL NORTE SALAMANDER

Plethodon elongatus VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 216 (type locality, Requa, Del Norte County, California); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 134; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 15; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 10; PRATT, Verteb. Animals of the U. S., 1923, p. 158; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 103; DUNN, Anniv. Publs. Smith College, 1926, p. 156.

Description.—"General form similar to *P. intermedius*, but with body, limbs and tail somewhat stouter: tail cylindro-conic, compressed laterally in posterior half, nearly equal to length of head and body, with strong vertical grooves nearly to tip: head somewhat depressed, about width of widest part of body; snout rounded from above and in profile: eyes moderate, separated anteriorly by about one and one-half times the length of the orbital slit: nostrils small, separated by about their distance from pupil; subnasal groove descending nearly to margin of lip; line of lip curved downward from below eye to end of snout: palatine teeth in two slightly curved series beginning just behind the internal nares, converging obliquely backward, and separated on the median line by a space greater than the diameter of the internal nares; parasphenoid teeth in one patch throughout, separated from the palatine teeth by an interval equal to distance from nostril to edge of lip; internal nares small; tongue large, ovate, not emarginate, attached along median line but free laterally and, for a short distance, behind; neck a little narrower than body, no parotoid gland, gular fold continued up and then forward as a groove to eye; a groove along vertebral line from head to tail; costal grooves between limbs 16, not continued to midline either above or below; limbs a little stouter than in *P. intermedius*, and with shorter digits, anterior with four and posterior with five digits; digits rather short, with rounded ends, each with a small terminal pad, inner shortest, third longest, second finger longer than fourth, second toe shorter than fifth, third and fourth toes nearly equal, broadly palmate but no web; adpressed limbs separated by about six costal folds.

"The coloration is similar to that of *P. intermedius*, but heavily clouded with black. The general color is blackish brown above and below; a broad, lighter brown, black-edged, dorsal band extending from snout to base of tail; lower surfaces sprinkled with small whitish dots, which become larger on the sides, gular region and chin" (Van Denburgh, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 216).

MEASUREMENTS OF 3 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	29	53	49
Front of anus to base of tail	15	38	58
Width of head	4	8	7½
Nostril to orbit	1½	2	1½
Snout to orbit	2	3	3
Snout to gular fold	7	12	11
Snout to fore limb	9	16	14½
Gular fold to anus	22	41	38
Axilla to groin	17	31	30
Adpressed limbs separated by	7	14	11
Fore limb	6	9	9
Hind limb	7	11	10½
Heel to end of longest toe	2½	5	5
Breadth of foot	1½	3	3½

Variation.—The three adult specimens are identical in structural characters and coloration. No. 29,101 is young, measuring 28 mm. from snout to anal opening, with tail 14 mm. long. It is like the three adults in the number of its costal folds and general coloration except that the dorsal band is bright pink, clouded on the head and along the mid-dorsal line with dark brown. This brightly colored band extends from the snout, along the back, nearly half way down the tail. This specimen looks very much like *P. intermedius*, but the lower surfaces are darker.

Remarks.—While this species is manifestly closely related to *Plethodon intermedius* and *P. vandykei*, it can easily be distinguished from both by the greater number of its costal grooves and the greater space between its adpressed limbs. The number of costal grooves is sixteen in all four specimens of this species, while in *Plethodon vandykei* these grooves are twelve and thirteen, and in *P. intermedius* they are thirteen or fourteen. *Plethodon intermedius* is of more slender build, with longer toes, more truncate snout, and less dusky coloration. The parotoid gland and webbed feet of *P. vandykei* are characters which should render its recognition easy.

Distribution.—This species is known only from four specimens collected near Requa, Del Norte County, California.

Habits.—The few specimens known were found under decaying logs in moist woods.

Plethodon vandykei Van Denburgh

WASHINGTON SALAMANDER

Plate 7

Plethodon vandykei VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, No. 4, 1906 (reprint 1915), p. 61 (type locality, **Paradise Valley, Mount Rainier Park, Washington**); STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 17; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 11; PRATT, Verteb. Animals of the U. S., 1923, p. 159; DUNN, Anniv. Publs. Smith College, 1926, p. 151.

Description.—"General form similar to *P. oregonensis* [=*Ensatina eschscholtzii*] but body not quite so much flattened, tail less compressed and limbs shorter and stouter; tail cylindro-conic, somewhat compressed in posterior half, nearly equal to length of head and body; head depressed, about width of widest part of body; snout broadly truncate from above, rounded in profile; eyes moderate, smaller than in *P. oregonensis*, rather prominent, separated anteriorly by nearly twice the length of the orbital slit; nostrils small, near corners of snout, separated by about their distance from pupil; subnasal groove descending nearly to margin of lip; line of lip descending slightly below corner of snout and ascending below posterior edge of orbit; palatine *teeth* in 2 slightly curved series beginning some distance behind and a little internal to the internal nares, converging obliquely backward, and scarcely separated on the median line; parasphenoid teeth in 1 patch throughout, separated from palatine teeth by an interval equal to distance from nostril to edge of lip; internal nares rather small; tongue large, ovate, not emarginate, attached along median line but free laterally and for a short distance behind; neck a little narrower than body, with large elongate parotoid gland divided by a longitudinal groove running posteriorly and downward from eye to gular fold, other grooves behind, above and in front of parotoid; a groove along vertebral line; *costal grooves* between limbs 12 on right, 13 on left, not continued to midline either above or below; limbs a little shorter and stouter than in *P. oregonensis* anterior with 4 and posterior with 5 digits; digits rather short, with broad rounded ends each with a terminal pad below, inner shortest, third longest, second finger longer than fourth, second toe shorter than fourth which is but little shorter than third; web well developed, extending nearly to end of inner digits, 2 phalanges of third and fourth toes free, feet very broadly palmate; tail slender, slightly compressed in posterior two-thirds, with rather indefinite grooves on proximal half; skin shiny, but roughened above and laterally and pitted below by the mouths of small glands; adpressed limbs separated by about the distance between 2 costal grooves.

"A broad band extends along the whole dorsal surface from the snout to the tip of the tail. In the alcoholic specimen this band is dark clay-color, dotted with black on the upper surface of the head. It is broadest on the back of the head and narrowest above the anus. The upper surfaces of the limbs and the side of the snout are clay-color dotted with black. A black line runs from the eye to the nostril. The hands and feet are black dotted with clay-color. The chin and central gular region are white with a few scattered black dots. The sides of the neck and the sides and lower surfaces of the body and tail are intense black with a few scattered whitish dots on the belly and sides of tail and with a zone of crowded white dots along the sides of the neck and body" (Van Denburgh, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, No. 4, p. 61).

Many specimens are much lighter in color than the one type described above. Often there is little black. In life the dorsal band is yellow and the tail is bright lemon yellow, brightest distally.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	43	43	47	53	53	60
Front of anus to end of tail	36	38	42	47	45	56
Width of head	6	6½	7	8	8	9
Nostril to orbit	2	2	2	2	2	2
Snout to orbit	2½	3	4	4	4	4
Snout to gular fold	10	10	11	12	12	13
Snout to fore limb	14	13	15	15	16	17
Gular fold to anus	33	33	36	41	41	47
Axilla to groin	24	24	25	30	30	34
Adpressed limbs separated by	2	2	1	4	4	3
Fore limb	11	11	13	14	14	15½
Hind limb	12	12	15	16	16	18½
Heel to end of longest toe	5	5	6	6	7	7
Breadth of foot	3	3	4	4	5	6

Distribution.—This salamander is known only from the vicinity of Puget Sound, Washington. It was first described from a specimen taken in Paradise Valley, Mount Rainier National Park, Pierce County. It has been found on the Calawa River near Forks, Clallam County, and in the Skokomish River Valley, Mason County.

Habits.—Specimens were found under stones along the upper edge of the bed of the Calawa River where small seepages from the banks kept the soil wet.

Genus 7. **Ensatina**

Ensatina Gray, Cat. Batrach. Grad. Brit. Mus., 1850, p. 48 (type, *eschscholtzii*).

In the salamanders of this genus both vomerine and parasphenoid teeth are present; the teeth in the jaws are not unusually large; the skull is well ossified; a prefrontal bone is present; there is a large fontanelle between the spines of the two premaxillary bones; the tongue is attached along the median line except posteriorly; the anterior limb has four digits and the posterior has five digits.

The salamanders of this genus are very closely related to those of the genus *Plethodon* from which they differ in having longer limbs, palmar tubercles, and a basal constriction of the tail.

SYNOPSIS OF SPECIES

a.—Upper surface of body unicolor, no light spots of yellow or orange .... **E. eschscholtzii.**—p. 60

a'.—Upper surface of body conspicuously spotted or blotched with yellow or orange .... **E. croceater.**—p. 63

Ensatina eschscholtzii (Gray)

RED SALAMANDER

Plate 8, figure 1

Ensatina Eschscholtzii GRAY, Cat. Amph. Brit. Mus., Pt. 2, 1850, p. 48 (type locality, California [Monterey, *fide* Boulenger]); STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 12; PRATT, Verteb. Animals of the U. S., 1923, p. 159; DUNN, Proc. New England Zool. Club, VII, 1923, p. 39; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 107; DUNN, Anniv. Publs. Smith College, 1926, p. 188.

Heredia oregonensis GIRARD, Proc. Acad. Nat. Sci. Phila., 1856, p. 140 (type locality, Oregon); HALLOWELL, Proc. Acad. Nat. Sci. Phila., 1856, p. 235; GIRARD, U. S. Explor. Exped., Herpt., 1858, p. 11, pl. I, figs. 18-25; STRAUCH, Mem. Acad. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 76.

Plethodon ensatus COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 167.

Plethodon oregonensis COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 100; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 27; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 67; BOULENGER, Cat. Batrach. Grad., 1882, p. 54; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 155, 192; COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 28; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 148, fig. 35; VAN DENBURGH, Proc. Amer. Philos. Soc., XXXVII, 1898, p. 140; HUBBARD, Univ. Calif. Publ. Zool., I, 1903, p. 157, pl. XVI; ESTERLY, Univ. Calif. Publ. Zool., I, 1904, p. 227, pls. XX-XXIII; RUTHLING, COPEIA, 1915, No. 25, p. 62; FOWLER & DUNN, Proc. Acad. Nat. Sci. Phila., 1917, p. 26.

Plethodon eschscholtzii GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, 1917, p. 132; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 15; DUNN, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 459.

Description.—General form not elongate, rather stout, limbs short and stout. Tail cylindro-conic, slightly compressed in posterior half; with marked constriction at base, where it often breaks; when complete, longer than head and body. Head depressed, about width of widest part of body. Snout broadly rounded from above, rounded in profile. Eyes very large, prominent, separated anteriorly by much less than twice the length of the orbital slit. Nostrils small, near corners of snout, separated by about their distance from orbit. Nasolabial groove descending nearly to margin of lip, where it forks. Line of lip descending slightly below posterior edge of orbit. Vomerine teeth in two long curved series beginning behind and much external to the internal nares, converging obliquely backward, and scarcely separated on the median line. Parasphenoid teeth in one patch anteriorly, slightly separated posteriorly, separated from vomerine teeth by an interval equal to distance from nostril to edge of lip. Internal nares rather small. Tongue large, ovate, not emarginate, attached along median line but free laterally and posteriorly. Neck a little narrower than body; a longitudinal groove running posteriorly and downward from eye to gular fold. No parotoid. A groove along vertebral line. Costal grooves between limbs usually eleven, rarely twelve, not continued to midline above. Anterior limbs with four and posterior with five digits. Digits rather short, without broad rounded ends; inner shortest, third longest; second finger longer than fourth; no web, three and a half phalanges of third and fourth toes free. Tail heavy, slightly compressed in posterior two-thirds, with very indefinite grooves, but with a strong constriction at base just behind the vent. Skin pitted with the mouths of small glands, especially on tail. Adpressed limbs overlap by about the distance between one to four costal grooves.

Color above yellowish- or reddish-brown or chestnut, without markings. Upper joints of both limbs and often supraocular regions light yellowish or whitish. Sides and all lower surfaces yellowish or whitish without markings.

Specimens from southwestern Oregon and Del Norte County, California, are mottled with blackish brown on sides and tail, and the middorsal and postorbital grooves may be blackish. The whitish supraocular spots are most constant in specimens from Monterey County, California.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	30	43	59	60	74	75
Front of anus to end of tail	18	37	68	71	65	31
Width of head	6	9	11	11	13	12
Nostril to orbit	2	3	4	4	4	4
Snout to orbit	3	4	6	6	6	6
Snout to gular fold	9	13	18	18	20	20
Snout to fore limb	11	16	20	21	23	22
Gular fold to anus	21	30	41	42	54	55
Axilla to groin	14	21	30	31	38	40
Adpressed limbs overlap	3	9	13	11	6	4
Fore limb	11	16	20	20	24	24
Hind limb	12	18	22	23	27	27
Heel to end of longest toe	4	8	9	10	12	11
Breadth of foot	2	4	4	5	6	6

Remarks.—This species and *E. croceater* are closely related. They have the same general proportions, the same number of costal grooves, and similar ground color, but differ in the yellow or orange spots or blotches which are present in *E. croceater* but not in *E. eschscholtzii.* Some individuals of *E. croceater* have the ground color relieved only by a number of small dots less than a millimeter in diameter. Should these spots ever be entirely absent in *E. croceater* the specimen involved doubtless would be referred to *E. eschscholtzii.* I am by no means certain that this has not been done in the case of our single specimen from Strawberry Valley, El Dorado County, which appears to be a typical *E. eschscholtzii.* Large series are needed to answer this question. Until these are secured these unspotted salamanders must be referred to *E. eschscholtzii.*

Distribution.—This salamander is known to occur from Washington to southern California.

Washington specimens are from Thurston (Tenino), Mason (Skokomish River Valley, Lake Cushman), Chehalis (Quiniault, Hoquiam), Snohomish (Monroe), King (Seattle), and Pacific (South Bend), counties.

In Oregon, it has been secured in Multnomah (Portland), Coos (Marshfield), Yamhill (McMinnville), and Curry (Port Orford. Harbor), counties.

In California, it is chiefly confined to the moist coast region but, subject to the above remarks, has been found also in the Sierra Nevada. It has been collected in Del Norte (Smith River, Requa, Castle Rock three miles north from Crescent City, Whale Rock in Crescent City Harbor), Siskiyou (Shasta), Shasta (Sweet Briar), Mendocino (Mendocino, Cahto, Comptche), Sonoma (Agua Caliente, Duncan Mills, Camp Meeker, Petaluma), Marin (Big Carson Creek, Tocaloma, Phoenix Gulch, Sausalito, Fort Baker, Point Bonita, Muir Woods, Mill Valley, Mount Tamalpais, Lagunitas), Alameda (Oakland, Berkeley) San Francisco (San Francisco), San Mateo (Redwood City), Santa Clara (Stanford University, Stevens Creek Canyon, Alum Rock, Los Gatos), Santa Cruz (Big Trees), Monterey (Monterey, Pacific Grove, Carmel), El Dorado (Strawberry Valley), Los Angeles (Topanga Canyon, Sierra Madre, Palmer's Canyon, Los Angeles), and San Bernardino (Forest Home at 5,200 feet in the San Bernardino Mountains, 10 miles N.W. from San Bernardino), counties.

Habits.—This salamander usually is found under rocks, boards, logs, etc., in damp situations. It is probably nocturnal, for it seldom if ever is found out in the daytime.

Van Denburgh (Proc. Amer. Philos. Soc., XXXVII, 1898, p. 140), Hubbard (Univ. Calif. Publ. Zool., I, 1903, p. 157), and Esterly (Univ. Calif. Publ. Zool., I, 1904, p. 227) have given excellent accounts of their observations upon this species.

Ensatina croceater (Cope)

SIERRA SALAMANDER

Plate 8, figure 2

Plethodon croceater COPE, Proc. Acad. Nat. Sci. Phila., 1867, p. 210 (type locality, "Fort Tejon", California [?]); COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 100; STRAUCH, Mem. Acad. Imper, Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 70; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, pp. 27, 92; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 68; LOCKINGTON, Amer. Naturalist, XIV, 1880, p. 295; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 55; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 192; COPE, Bull. U. S. Nat. Mus., No. 32, 1887, p. 9; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 150; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 561; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 220; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10. 1917, p. 132; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 14; NELSON, Mem. Nat. Acad. Sci., XVI, 1921. p. 113; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI. 1922. pp. 612, 615, 632.

Ensatina croceater STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 12; PRATT, Verteb. Animals of the U. S., 1923, p. 160; DUNN, Proc. New England Zool. Club, VII, 1923. p. 39; DUNN, Copeia, 1924, No. 133, p. 76; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 104; DUNN, Anniv. Publs. Smith College, 1926, p. 185; KLAUBER, Zool. Soc. San Diego, Bull. No. 3, 1927, p. 2.

Description.—General form rather stout and thick-set. limbs stout and well developed, tail strongly compressed distally. Head somewhat depressed, about width of widest part of body. Snout rounded or truncate when seen from above, rounded and overhanging in profile. Eyes large and prominent. separated anteriorly by nearly twice the length of the orbital slit. Nostrils small. near corners of snout. separated by their distance from pupil. A nasolabial groove descending to margin of lip. where it sometimes forks. Line of lip nearly straight. but descending slightly below corner of snout and behind eye. Vomerine teeth in two curved series, beginning a little behind and much external to the internal nares, converging obliquely backward and meeting or nearly meeting on the median line. Parasphenoid teeth in two patches, in contact anteriorly but separated behind: separated from vomerine teeth by about one-half distance between internal nares. Tongue ovoid, not emarginate, quite free laterally and posteriorly. Neck about as wide as body, a strongly marked groove running back and down from the eye to the transverse gular fold,one or more transverse grooves on side of neck; no parotoid. A groove along vertebral line from head to base of tail. Costal grooves not always distinct anteriorly, normally eleven between limbs rarely ten or twelve, not extending to midline of back but sometimes continued across belly. Anterior limbs with four and posterior with five digits. Digits rather slender and elongate, except inner, which are moderate: third finger longest, second longer than fourth, third and fourth equal or fourth longer; no web, three phalanges of third and fourth toes free, and usually ends of metatarsals also. Tail with marked constriction behind anus, strongly compressed distally, with more or less indefinite lateral grooves proximally. Skin everywhere very smooth and shiny but dotted with the mouths of small glands. Adpressed limbs overlapping a distance equal to two to four costal interspaces.

Color in alcohol, above yellowish-brown, reddish-brown, or brownish black, variously dotted, spotted, blotched, or marbled with yellowish orange. Scarcely two individuals are marked alike. The dark ground-color may be relieved only by a number of small dots less than a millimeter in diameter, or there may remain of ground-color of dorsal region of body only narrow, irregular bands separating light blotches seven to nine millimeters across. As a rule the light markings are more restricted in small than in larger specimens. The blotches may have regular, more or less circular outlines, but usually are quite irregular both in outline and arrangement. Often there is a large blotch on each parotoid region, but these markings may be confluent or absent. Upper surface of tail usually blotched with yellow or orange. Distal portions of limbs dark, while thigh and upper arm are light in color. Lower surfaces are whitish, yellowish, or orange, often clouded with brown.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	20	32	51	57	63	74
Front of anus to end of tail	12	22	41	58	66	60
Width of head	5	7	10	11	12	12
Snout to orbit	3	3	5	6	6	6
Snout to gular fold	6	10	15	17	19	21
Snout to fore limb	8	12	18	20	24	25
Gular fold to anus	14	22	36	40	44	53
Axilla to groin	10	16	26	29	30	38
Adpressed limbs overlap	3	5	7	4	4	5
Fore limb	8	12	19	12	23	23
Hind limb	8	13	20	21	24	25
Heel to end of longest toe	3	5	7	8	10	10
Breadth of foot	1	3	4	5	6	6

Distribution.—This salamander is known from California and Lower California.

The only Lower California specimen taken was recorded by Mr. Lockington as collected seventy-five miles southeast of San Diego. This locality probably was in the San Pedro Martir Mountains. Cope has recorded the species from Cape San Lucas. probably an error resulting from association of the original specimen with John Xantus. who collected both at Cape San Lucas and Fort Tejon.

In California. this salamander is known from the San Jacinto Mountains, and Sierra Nevada. It has been collected in San Diego (Oakzanita. Rose Mine in the Laguna Mountains), Riverside (San Jacinto Mountains). Kern (near Fort Tejon), Tulare (Kaweah. Colony Mill. White River, Giant Forest. Sequoia National Park. Mud Spring at 6.300 feet four miles west from Nelson), Fresno (Dalton River), Madera (North Fork, Malum Ridge). Calaveras (Mokelumne Hill), Placer (Alta at 3,600 feet), Tuolumne (Yosemite Valley). and Siskiyou (Shasta Retreat), counties.

Habits.—This species inhabits damp places in forests.

Genus 8. **Aneides**

Aneides Baird, Iconogr, Encycl., II, 1849, Zool., p. 257 (type, *lugubris*).
Autodax Boulenger, Ann. & Mag. Nat. Hist., XIX, 1887, p. 67 (type, *lugubris*).

In this genus vomerine and parasphenoid teeth are present. The teeth in the jaws are large. compressed. knife-shaped. few in number. and are present only in the anterior part of the mouth. the posterior portions of both jaws being edentulous. The premaxillary bone is single with a fontanelle. The tongue is attached along the median line, except posteriorly. The limbs are well developed, the anterior with four and posterior with five digits. In adults the temporal regions become much swollen. The line of lip is deflected upward posteriorly.

Three very distinct species are known, one of which may be divided into two subspecies. All are confined to the Pacific Coast.

Synopsis of Species and Subspecies

a.—Tail compressed distally. Black, usually more or less sprinkled with small silvery dots or spots..A. **flavipunctatus**.—p. 66

a'.—Tail cylindrical or oval throughout.

  b.—Size smaller; ground color yellowish or reddish-brown: dorsal surfaces clouded, marbled or blotched with dark brown or slate........................A. **ferreus**.—p. 69

  b'.—Size larger.

    c.—Dorsal surfaces unicolor or with small light yellow dots or spots........................A. l. **lugubris**.—p. 71

    c^2.—Dorsal surfaces never unicolor: yellow spots larger and more numerous........................A. l. **farallonensis**.—p. 74

Aneides flavipunctatus (Strauch)

Black Salamander

Plate 9, figure 1

Plethodon flavipunctatus Strauch, Mem. Acad. Sci. St. Petersb., XVI, 1870, p. 71 (type locality, New Albion, California).

Aneides flavipunctatus Storer, Univ. Calif. Publ. Zool, XXVII, 1925, p. 119.

Plethodon iëcanus Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 24 (type locality, Baird, Shasta County, California); Townsend, Proc. U. S. Nat. Mus., X, 1887, p. 240.

Anaides iëcanus Cope, Proc. Amer. Philos. Soc., 1886, p. 526.

Autodax iëcanus Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 187, fig. 46; Van Denburgh, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 776; Cope, Amer. Nat., XXX, 1896, p. 325; Dice, Univ. Calif. Publ. Zool., XVI, 1916, p. 306; Fowler & Dunn, Proc. Acad. Nat. Sci. Phila., 1917, p. 23.

Aneides iëcanus Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 135; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 21; Dunn, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 463; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 18; Pratt, Verteb. Animals of the U. S., 1923, p. 160.

Description.—General form less stout than *A. l. lugubris.* Head but little broader than body, with temporal regions in adults slightly swollen. Limbs fairly strong and well developed, tail cylindrical, slightly compressed distally. Head somewhat depressed, elongate. Snout truncate when seen from above, overhanging in profile. Eyes moderate, separated anteriorly by the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by little less than their distance from pupil. An indistinct nasolabial groove, descending nearly to margin of lip. Line of lip nearly straight, or bending slightly upward at a point below the middle of the orbit. Parasphenoid teeth forming a broad patch, extending to a point midway between the eye sockets and divided by a slight median groove. Vomerine teeth in an open V-shaped patch separated posteriorly and reaching anteriorly to the internal nares. Internal and external nares about equidistant. Tongue wedge-shaped, thin posteriorly, quite free laterally and posteriorly, attached along the median line. Costal grooves normally twelve between limbs, extending nearly to midline on back and continued across the belly. A well defined dorsal groove. Anterior limbs with four and posterior with five digits. Digits rather slender with terminal disk-like expansions; inner quite small, third anterior and posterior longest, second and fourth nearly equal. No web. Tail with well marked lateral grooves except distally. Adpressed limbs fail to meet by a distance equal to three to five costal interspaces.

Color in alcohol uniform black. Top and sides of head, neck, body, limbs and tail covered with small whitish or yellowish spots. Under surfaces of feet light brown.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	52	58	64	64	65	71
Front of anus to end of tail	42	46	47	52	60	65
Width of head	7	8	11	10	10	13
Snout to orbit	2	3	2	3	3	4
Snout to gular fold	13	15	18	19	16	17
Snout to fore limb	15	19	22	22	20	22
Gular fold to anus	37	43	47	46	49	54
Axilla to groin	30	33	35	34	38	43
Adpressed limbs fail to meet by	10	15	10	7	16	11
Fore limb	11	13	13	13	14	15
Hind limb	12	14	16	17	17	18
Heel to end of longest toe	6	7	7	7	8	7
Breadth of foot	5	6	6	7	7	8

Distribution.—This black salamander has been found only in northern California, where it has been collected in Shasta (Sweet Briar, Baird, McCloud River), Humboldt, Mendocino (Comptche, Laytonville, Ukiah), Sonoma (Skaggs Springs, Camp Meeker), Napa (Calistoga), Santa Clara (Stevens Creek, Mountain View, Los Gatos), and Santa Cruz (Glenwood, Boulder Creek), counties.

The type locality, New Albion, California, is probably in Sonoma County.

The record, by Lee R. Dice, of *Aneides iëcanus* from Walla Walla or Columbia counties pertains to *Ambystoma macrodactylum.*

Habits.—Dr. Van Denburgh writes of its habits as follows (Proc. Calif. Acad. Sci., Ser. 2, V, 1895, pp. 776-778): "*Autodax iëcanus*, doubtless, is a nocturnal forager. I have seen it upon the surface of the ground only twice, and in each instance night was so nearly at hand that objects near my feet could just be distinguished. If liberated during the day, or if confronted with a light at night, when it is much more active, this species will proceed, almost invariably, toward the nearest spot of darkness or shadow. It usually walks along quite slowly, moving but one foot at a time, but is capable of motion surprisingly rapid for a salamander. When moving rapidly, it aids the action of its legs by a sinuous movement of its whole body and tail. . . .

"A large *Autodax iëcanus* and fifteen eggs were sent me from Los Gatos, July 23. 1895. The eggs were evidently those of a batrachian, doubtless of this species. Each egg was about 6 mm. in diameter, almost spherical, and inclosed in a thin, tough, gelatinous sheath. Each of these sheaths was drawn out, at one place, into a slender peduncle, which was attached to a basal mass of the same gelatinous substance. In this way, each egg was at the end of an individual stalk, and all were fastened to a common base. This base had evidently been anchored to a stone or lump of earth. The eggs were in the early stages of segmentation. The following note accompanied them: 'The salamander and eggs were found under the platform in front of a barn, in dry earth next the foundation wall, and about fifteen inches or more below the surface. The ground had been filled in, and was full of spaces. There was some dry rotten wood near the eggs. One or two smaller salamanders were near. About twice as many eggs were found as sent. There was no water within ten or fifteen feet.' The salamander sent with these eggs was a female, and had a very large number of minute eggs in its ovaries.

"On July 30, 1895, I killed a very large Autodax which had been sent me, from Los Gatos, several days before. It contained twenty-five eggs exactly like those described above, except that they lacked the gelatinous covering. These eggs appeared to be still in the ovaries. There were twelve on the right side of the animal, and thirteen on the left. Besides these enlarged ones, there were many minute ova."

Aneides ferreus Cope

CLOUDED SALAMANDER

Plate 9, figure 2

Anaides ferreus COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 109 (type locality,Fort Umpqua, Douglas County, Oregon); COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 28; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 61; BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 53; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 159, 193.

Autodax ferreus COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 185, fig. 45; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, VI, No. 7, 1916, p. 216.

Aneides ferreus GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 135; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 21; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 18; PRATT, Verteb. Animals of the U. S., 1923, p. 160; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 117; HARDY, Rep. Prov. Mus. Brit. Columbia, 1925, p. c23; DUNN, Anniv. Publs. Smith College, 1926, p. 208.

Description.—General form rather less stout than *A. l. lugubris*, half-grown specimens being quite slender, and with head but little broader than body, while adults have temporal regions swollen as in *A. l. lugubris*. Limbs fairly strong and well developed, tail cylindro-conic or slightly compressed distally. Head somewhat depressed, elongate. Snout truncate when seen from above, overhanging in profile. Eyes large and prominent, separated anteriorly by about twice the length of the orbital slit. Nostrils small, opening laterally near corners of snout, separated by their distance from pupil. A nasolabial groove, descending nearly to margin of lip. Line of lip very slightly undulate in young, curved strongly upward behind middle of orbit in adult. Vomerine teeth forming a low or open V-shaped or simply curved series with the ends extending to the inner and posterior margins of the nares. Parasphenoid teeth in a single well developed patch, separated from vomerine teeth by less than the distance between internal nares. Internal nares nearer together than external. Tongue ovoid, thin posteriorly, not emarginate, quite free laterally and posteriorly, attached along median line. Neck rather short, about width of body. Costal grooves normally 14, rarely 15[1], between limbs, rarely extending to midline of back or continued across belly. Anterior limbs with four and posterior with five digits. Digits rather slender with terminal disk-like expansions; inner quite small, third anterior and fourth posterior longest, second and fourth fingers nearly equal, second toe shorter than fifth; no web. Tail without constriction behind vent; with well marked lateral grooves, except distally. Adpressed limbs fail to meet by a distance equal to one or two costal interspaces.

Color in alcohol above yellowish- or reddish-brown mottled or reticulated with darker brown or black and often dotted with yellow. Median zone darkest and sides lighter, owing to the presence there of larger or more numerous yellow dots or blotches. In some specimens the central dorsal zone is black or steel-gray in the form of a more or less undulate band. Limbs and tail similarly marked above. Lower surfaces dirty yellow or gray, sometimes without, but usually with, numerous whitish dots.

Three young specimens (snout to anus 21 to 24 mm.) have the upper surface of the snout, upper surfaces of arms and legs, and an area on the dorsal portion of the neck yellowish-white. These markings show only on the forelimbs in a specimen measuring thirty-five millimeters from snout to vent, and not at all in larger specimens.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	24	39	44	49	56	61
Front of anus to end of tail	16	32	37	38	41	54
Width of head	4	6	7	7	9	10
Snout to orbit	2	2	3	3	3	4
Snout to gular fold	7	10	11	12	14	15
Snout to fore limb	8	13	14	16	17	19
Gular fold to anus	17	29	33	37	42	46
Axilla to groin	13	22	25	29	33	36
Adpressed limbs fail to meet by	1	3	2	3	2	5
Fore limb	6	10	11	13	14	15
Hind limb	7	11	14	15	16	17
Heel to end of longest toe	2	5	5	6	6	8
Breadth of foot	2	2	2	3	3	4

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[1] In twenty-nine counts the costal grooves are found to be 14 seventeen times, 14½ nine times, and 15 three times.

Remarks.—This species is much more closely related to *A. l. lugubris* than is *A. flavipunctatus.* The maxillary teeth are few, large, curved or angulate, compressed, with knife-like edges.

Distribution.—The range of this salamander extends from British Columbia to northwestern California.

In British Columbia it has been found on Vancouver Island, at Sydney, Sooke, Mount Finlayson, and Mount Douglas; and on small nearby islands: Bayne Island, Union Bay, and Denman Island.

I know of no records from the state of Washington.

In Oregon, it has been collected in Lane (Elmira), Coos (Marshfield), and Douglas (Fort Umpqua), counties.

In California, it has been secured in Del Norte (Requa), Humboldt (Alton, Trinidad, Carlotta, Orick), and Mendocino (Comptche), counties.

Habits.—Two females (56 and 58 mm. from snout to anus) collected on Bayne Island, May 16, 1906, contain eggs four millimeters in diameter. These are without pigment.

Two specimens from Requa were found by the writer in the rotten wood of a dead tree in which they were living some twenty feet above the ground. In Humboldt County, this species was secured under the loose bark of fallen logs.

Aneides lugubris lugubris (Hallowell)

CALIFORNIA YELLOW-DOTTED SALAMANDER

Plate 10, figure 1

[?] *Triton tereticauda* ESCHSCHOLTZ, Zool. Atlas, Pt. 5, 1883, p. 14 type locality, Fort Ross [Sonoma County, California]).

Salamandra lugubris HALLOWELL, Proc. Acad. Nat. Sci. Phila., IV, 1848, p. 126 (type locality, Monterey, Upper California).

Anaides lugubris BAIRD, Iconog. Encycl., II, 1849, p. 257; BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., 1853, p. 302; GIRARD, U. S. Explor. Exped., Herpt., 1858, p. 8, pl. I, figs. 26-33; BAIRD, Rep. Pac. R. R. Surv., X, 1859, p. 13, pl. XXX, fig. 4; COPE, Proc. Acad. Nat. Sci. Phila., 1869, p. 109; STRAUCH, Mem. Acad. Sci. St. Petersb., Ser. 7, XVI, No. 4, 1870, p. 75; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 28; WIEDERSHEIM, Morph. Jahrb. 3, 1877, pl. 25, figs. 104-106; SMITH, The Tailed Amphibians including the Cæcilians, 1877, p. 61; BOULENGER, Cat. Batrach. Brit. Mus., 1882, p. 52; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 158; EMMEL, Anat. Rec., 21, 1921, p. 56; EMMEL, Amer.

Journ. Anat., 1924, p. 351, pl. I, fig. 29, pl. 5, figs. 45, 47, 49; Valliant, Bull. Soc. Phil. Paris, VI, 1882, p. 183; VIII, 1886, p. 42.

Taricha ? lugubris Gray, Cat. Batrach. Grad. Brit. Mus., 1850, p. 26.

Ambystoma punctulatum Gray, Cat. Amph. Brit. Mus., 1850, p. 37 (type locality, Monterey).

Aneides lugubris Hallowell, Proc. Acad. Nat. Sci. Phila., 1856, p. 10; Hallowell, Journ. Acad. Nat. Sci. Phila., III, p. 345; Hallowell, Rep. Pac. R. R. Surv., X, 1859, p. 23, pl. 7, fig. 2; Cooper, Proc. Calif. Acad. Sci., IV, 1870, p. 64; Wilder, Anat. Anz., 12, p. 191; Snook & Long, Univ. Calif. Publ. Zool., XI, 1914, p. 511; Dunn, Bull. Mus. Comp. Zool., LXII, No. 9, 1918, p. 463; Noble, Bull. Amer. Mus. Nat. Hist., XLIV, 1921, p. 5; Stephens, Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 64; Pratt, Verteb. Animals of the U. S., 1923, p. 160.

? *Plethodon crassulus* Cope, Proc. Amer. Philos. Soc., XXIII, 1886, p. 521 (type locality, California); Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 147, fig. 34, pl. LXXXI, fig. 1; Fowler & Dunn, Proc. Acad. Nat. Sci. Phila., 1917, p. 25.

Autodax lugubris Boulenger, Ann. Mag. Nat. Hist., XIX, 1887, p. 67; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 183, fig. 44, pls. XXVII, figs. 1-4, XXXV, fig. 3, XLVIII, fig. 15; Keeler, Zoe, III, 1892, p. 154; Ritter & Miller, Amer. Nat., XXXIII, 1899, p. 691; Ritter, Amer. Nat., XXXVII, 1903, p. 883; Miller, Amer. Nat., XL, 1906, p. 741; Hilton, Amer. Nat., XLIII, p. 53; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, IV, 1914, pp. 132, 139; Ruthling, Copeia, No. 25, 1915, p. 62; Fowler & Dunn, Proc. Acad. Nat. Sci. Phila., 1917, p. 23.

Aneides lugubris lugubris Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 134; Stejneger & Barbour, Check List. N. Amer. Amph. Rept., 1917, p. 21; Nelson, Mem. Nat. Acad. Sci., XVI, 1921, p. 113; Schmidt, Bull. Amer. Mus. Nat. Hist., XLVI, 1922, pp. 615, 633; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 18; Grinnell & Storer, Animal Life in the Yosemite, 1924, p. 653; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 124; Klauber, Zool. Soc. San Diego, Bull. No. 3, 1927, p. 4.

Description.—Head elongate, depressed, with truncate protruding snout. Nostrils small, a little above and behind corner of snout. Nasolabial groove prominent, reaching to edge of lip. Nostril separated from its fellow by length of orbital slit. Lip margin long and undulating. A well defined dorsal groove reaching from base of tail to a point midway between the orbits, more prominent anteriorly. Maxillary and mandibular teeth large. A large prominent patch of parasphenoid teeth, single or sometimes divided by a slight median groove. Tongue large, long, ovate, with a small posterior notch, free except along median line. Neck short, somewhat constricted, a well-developed gular fold. Body fusiform. Thirteen to thirteen and one-half costal grooves between limbs, extending from a short distance from vertebral line entirely across the belly. Tail conical with similar transverse grooves. Limbs well developed, posterior longer than anterior. Toes meeting when adpressed. Front limb with four, hind limb with five digits, nearly free, with small terminal disk-like expansions; third finger longest, first short, second and fourth equal or nearly equal. Skin smooth.

Color above brown or light brown, lightest on snout and limbs. Sides of neck, body, limbs and tail sparsely spotted with pale straw-yellow. In some specimens this spotting is entirely absent. Under surfaces yellowish or whitish.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	57	63	67	71	74	81
Front of anus to end of tail	40	52	66	68	66	71
Width of head	8	12	12	13	14	18
Snout to orbit	3	4	4	4	4	4
Snout to gular fold	13	18	20	20	21	24
Snout to fore limb	17	22	23	24	26	29
Gular fold to anus	44	45	47	51	53	57
Axilla to groin	23	33	38	38	40	42
Fore limb	13	17	20	20	20	23
Hind limb	17	21	23	22	23	24
Heel to end of longest toe	7	12	11	10	12	9
Breadth of foot	8	12	12	11	12	11

Distribution.—This salamander has been found only in California and Lower California.

In California, it occurs throughout nearly the whole length of the state. It is most abundant in the coast region, but has been found in the San Joaquin Valley and on the western slope of the Sierra Nevada. Specimens have been secured in Humboldt (Carlotta), Mendocino (Comptche, Mendocino City, Willits), Sonoma (Duncan Mills, Camp Meeker, Freestone, Petaluma), Marin (three miles west from Inverness, Fairfax, Mount Tamalpais, Redwood, four miles west from Sausalito, Sausalito), Napa (Calistoga, St. Helena, Luscol, Napa, two miles southwest from Napa), Contra Costa (Red Rock in San Francisco Bay), Alameda (Albany, Berkeley, Moraga Valley, East Oakland at Trestle Glen, Haywards), San Francisco (Presidio, Golden Gate Park), San Mateo (Colma, San Bruno Hills, San Mateo, San Andreas Lake, Menlo Park), Santa Clara (Stanford University, Palo Alto, Mountain View, San Jose, Los Gatos, Uvas Valley), Santa Cruz (Brookdale), San Benito

(Hollister, Bear Valley, San Juan), Monterey (Monterey, Pacific Grove, Carmel, Pescadero Point, six miles northeast from Soledad), Merced (Sweeney's Ranch near Los Baños), Calaveras (Mokelumne Hill), Mariposa (Coulterville, three miles northeast from Coulterville), Madera (North Fork at 2,750 and 3,000 feet), Kern (Fort Tejon), Santa Barbara (Santa Barbara), Ventura (Nordhoff), Los Angeles (Los Angeles, Tropico, Eaton's Wash near Pasadena, Sierra Madre, three miles southeast from Lankershim, Topango Canyon near Santa Monica), Riverside (Ontario, San Jacinto), and San Diego (Falls of the San Diego River, Sorrento Mountain near La Jolla), counties

In Lower California it has been collected only on Los Coronados Islands.

Habits.—This terrestrial salamander often is found under stones or logs or in decaying wood or cavities of trees. It is abundant in the coast region, and while collecting at Carmel, Monterey County, California, the writer has found as many as seven adults under a single board. A rock pile consisting of half-a-dozen small rocks was found to harbor no less than thirteen. Ritter and Miller (Amer. Nat., XXXIII, 1899, pp. 691-700) have written extensively on its habits.

Aneides lugubris farallonensis (Van Denburgh)

FARALLON YELLOW-DOTTED SALAMANDER

Plate 10, figure 2

Anaides lugubris BOULENGER, Cat. Batrach. Grad. Brit. Mus., 1882, p. 52 (part); YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 158 (part).

Autodax lugubris COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 183 (part); KEELER, Zoe, III, No. 2, 1892, p. 154.

Autodax lugubris farallonensis VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, 1905, pp. 3, 5, pl. II, figs. 1-7 (type locality, **South Farallon Island, San Francisco County, California**); VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, IV, 1914, pp. 132, 134.

Aneides lugubris farallonensis GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 135; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 21; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 18; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 140.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	55	58	56	57	66	66
Front of anus to end of tail	50	49	50	53	55	57
Width of head	10	11	10	10	14	13
Snout to orbit	3	4	4	3	4	4
Snout to gular fold	16	18	16	16	19	20
Snout to fore limb	19	20	20	21	22	22
Gular fold to anus	39	40	40	41	47	46
Axilla to groin	30	30	30	32	34	32
Adpressed limbs overlap	4	4	4	3	2	5
Fore limb	18	18	15	18	20	20
Hind limb	20	20	20	21	25	25
Heel to end of longest toe	8	9	8	10	9	11
Breadth of foot	10	10	9	9	11	11

Distribution.—This salamander is known only from South Farallon Island, San Francisco County, California.

Remarks.—Dunn[1] does not distinguish this subspecies from *A. l. lugubris*, but, in the examination of sixty-seven specimens in the Academy's series the limbs were found to be longer than in *A. l. lugubris*, the spotting more pronounced, often forming blotches, and extending on to the dorsal surfaces. All of the specimens are whitish below. I believe therefore that this salamander should be given subspecific distinction.

Habits.—The specimens collected have been found under piles of loose stone in moist places.

Description.—Head elongate, depressed, with truncate, protruding snout. Nostril small, a little above and behind corner of snout, with groove running down to edge of lip, separated from its fellow and from orbit by length of eye-slit. Lip margin long and undulating. Maxillary and mandibular teeth large. Vomerine teeth small, in series running back from each inner nostril and forming a V-shaped figure. A large well-defined patch of parasphenoid teeth, divided by a slight median groove and posterior notch. Tongue large, long, ovate, with a small posterior notch, free except along the median line. Neck short, somewhat constricted, a well developed gular fold. Body fusiform. Thirteen costal grooves between limbs extending from a short distance from vertebral line entirely across belly. Tail conical, with similar transverse grooves. Limbs well developed, posterior longer than anterior, toes overlapping when adpressed. Front limb with four, hind limb with five digits, all well developed, nearly free, with slight terminal disk-like expansions; third finger longest, first short, second and fourth nearly equal. Skin everywhere smooth, but dotted with the mouths of small glands.

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[1] Anniv. Publs. Smith College, 1926, p. 219.

Color above seal-brown, or yellowish-brown, lightest on snout and limbs, dotted, spotted and blotched with pale straw-yellow on top and sides of head, neck, body, limbs and tail. Under surfaces are very pale yellow or whitish.

The largest blotches usually are larger and more numerous than in *A. l. lugubris* and may measure as much as two by four millimeters in diameter.

Genus 9. Hydromantes

Hydromantes GISTEL, Naturg. Thierr., 1848, p. XI (type, *genei*).

In the salamanders of this genus the tongue is attached by a central pedicel. A fontanelle is present. The digits are webbed about half way to the tips. The tail is cylindrical. Represented by a single species in North America.

Hydromantes platycephala (Camp)

MOUNT LYELL SALAMANDER

Plate 10, figure 3

Spelerpes platycephalus CAMP, Univ. Calif. Publ. Zool., XVII, No. 3, 1916, p. 11, figs. 1-5 (type locality, **head of Lyell Canyon, 10,800 feet altitude, Yosemite National Park, Tuolumne County, California**); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 132.

Eurycea platycephala STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 20; GRINNELL & STORER, Animal Life in the Yosemite, 1924, p. 652.

Hydromantes platycephalus DUNN, Proc. New England Zool. Club, VIII, 1923, p. 40; DUNN, Anniv. Publs. Smith College, 1926, p. 352.

Hydromantes platycephala STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 17; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 114.

Description.—General form rather elongate and slender. Limbs fairly stout and well developed. Tail not compressed distally. Head broad and depressed, little wider than widest part of body. Snout rounded or truncate when seen from above, overhanging in profile. Eyes rather small, separated anteriorly by a little less than twice the length of the orbital slit. Nostrils minute, near corners of snout, separated by about their distance from pupil; a nasolabial groove barely distinguishable descending toward margin of lip. Line of lip nearly straight but descending slightly near corner of mouth. Vomerine teeth in two curved series, beginning a little behind and much external to the internal nares, converging obliquely backward and meeting or nearly meeting on the median line. Parasphenoid teeth in two elongate patches, nearly in contact anteriorly but widely separated behind, separated from vomerine teeth by a little less than distance between internal nares. Tongue rounded, not emarginate, quite free anteriorly, laterally and posteriorly, attached only by a central pedicle, extending thirty to forty millimeters. Neck not quite as wide as body; no parotoid: a strongly marked groove running back and down from eye to the transverse gular fold; other transverse grooves on side of neck. A groove along vertebral line from head to base of tail. Costal grooves twelve between limbs. Anterior limbs with four and posterior with five digits. Digits not elongate, inner moderate or short; fingers and toes slightly enlarged at ends, webbed about half way to tips. one or two phalanges of third and fourth toes free. Tail cylindrical. much shorter than head and body. Adpressed limbs fail to meet by a distance equal to one or two costal interspaces.

Ground color above a rich dark-brown. profusely marbled or spotted with silvery gray. Under surfaces lighter brown, gular region with large grayish spots.

MEASUREMENTS OF 5 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	58	59	60	60	63
Front of anus to end of tail	37	35	35	40	34+
Width of head	11	10	11	10	12
Snout to orbit	3	3	4	3	2
Snout to gular fold	12	13	14	13	15
Snout to fore limb	17	17	18	17	19
Gular fold to anus	43	46	46	46	48
Axilla to groin	31	33	33	37	35
Adpressed limbs fail to meet by	7	10	7	8	5
Fore limb	13	12	13	13	17
Hind limb	14	13	16	15	17
Heel to end of longest toe	8	8	8	8	7
Breadth of foot	6	6	8	7	8

Distribution.—This small salamander is known only from seven specimens taken in Yosemite National Park. Mr. Charles Camp who took two of these specimens states: "The two Mount Lyell salamanders were taken on the rocky, snow-crowned north slope of Mount Lyell, in the Yosemite National Park, about a mile from the glacier and a little below timber line, here marked by a few stunted white-bark pines on the tops of the ridges. The exact spot was at the 10,800-foot contour, on a steep, east-facing hillside above the Donohue Pass trail in a small patch of heather. A stream close by issued directly from the snow banks and disappeared beneath rock-slides below. The two specimens were found to have been captured simultaneously in a spring-clip mouse-trap set in front of a small hole running into the moist soil beneath some rocks."

Remarks.—The writer with the late Dr. Van Denburgh visited the type locality on August 27, 1922, and collected the remaining five known specimens. These were found under large rocks at the margin of an ice-cold stream flowing from the snow banks.

Order II. SALIENTIA

The order Salientia includes all of the tailless amphibians, such as the frogs and toads. Two suborders of Salientia are represented in the area included in this work. These are the suborder Costata, in which rudimentary ribs are present, and the suborder Linguata, in which the vertebræ bear no ribs.

Synopsis of Families

a.—Eye with pupil vertically elongate; upper jaw with teeth.
  b.—Sole of hind foot without horny scraper; male with a short "tail": ribs present: parotoid present........................ **Discoglossidæ.**—p. 79
  b^2.—Sole of hind foot with a horny scraper; male without a "tail": no ribs: parotoid not developed........................ **Scaphiopodidæ.**—p. 83
a .—Eye with pupil horizontally elongate or round; upper jaw with or without teeth; no ribs.
  bb.—Parotoid glands well developed; jaws without teeth; digits without terminal disks........................**Bufonidæ.**—p. 89
  bb^2.—No parotoid glands; upper jaw with teeth.
    c.—Tips of digits broadened into adhesive disks; skin of belly granular........................**Hylidæ.**—p. 110
    c^2.—Tips of digits not broadened into disks; skin of belly usually smooth........................**Ranidæ.**—p. 120

Suborder II. COSTATA

This suborder is represented by a single family.

Family 4. DISCOGLOSSIDÆ

In the members of this family the diapophyses of the second, third and fourth vertebræ bear short ribs. The tongue is rounded and, being attached by nearly the whole of its base, cannot be protruded. The vertebræ are opisthocœlous. The sacral diapophyses are dilated. Teeth are present in the upper jaw and on the vomers. There is no vocal sac.

Representatives of this family have been found in Europe, Africa, Asia, New Zealand, and North America. There is but one American genus.

Genus 10. Ascaphus

Ascaphus STEJNEGER, Proc. U. S. Nat. Mus., XXI, 1899, p. 899 (type, *truei*).

This genus, of which only one species is known, is characterized as follows: Typanum and eustachian tubes not visible (probably absent); pupil elliptical, vertical; diapophyses of sacral verterbræ moderately dilated; tongue free behind; second rib with a posterior process; sternum a narrow transverse band of cartilage; urostyle articulated to a single condyle; vomerine teeth in two small groups between choanæ; parotoid gland well developed.

Upper jaw toothed; shoulder girdle of the arciferous type; precoracoid but slightly curved; coracoid short; epicoracoid cartilage very broad; apparently no omosternum; sternum a narrow transverse cartilage with a short posterior median process; tongue thick, broadly pear-shaped, slightly emarginate and free behind, adherent in front; urostyle with two basal transverse processes directed obliquely backward, the articular surface quite flat; outer metatarsals separated by web; fingers free; toes slightly webbed: no subarticular tubercles; tips of digits obtusely pointed; inner metatarsal slight.

Ascaphus truei Stejneger

AMERICAN RIBBED TOAD

Plate 11, figure 1

Ascaphus truei STEJNEGER, Proc. U. S. Nat. Mus., XXI, 1899, p. 900, pl. LXXXIX (type locality, **Humptulips**, Chehalis County, Washington); Dickerson, Frog Book, 1906, p. 51; Van Denburgh, Proc. Calif. Acad Sci., Ser. 4, III, 1912, p. 259; Camp, Copeia, 1917, No. 40, p. 13; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 139; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 25; Gaige, Occas. Papers Mus. Zool. Univ. Mich., No. 84, 1920, pp. 1-9, pl. I; Van Winkle, Copeia, 1922, No. 102, p. 4; Noble, Copeia, 1922, No. 102, p. 6; Noble, Bull. Amer. Mus. Nat. Hist., XLVI, 1922, pp. 26-28, 30-36, 43-45, 52, 55, 56, 74; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 22; Pratt, Verteb. Animals of the U. S., 1923, p. 168; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 143.

Description.—Head flattened, slightly broader than long. Snout obtusely pointed, longer than diameter of orbit, high, descending abruptly, with well developed canthus rostralis. Nostril nearer to orbit than to end of snout. Eye moderate, with vertically-elliptic pupil. Interorbital space much less than distance between nostrils. No distinct tympanum. Skin above nearly smooth with a few warts over pelvis and thigh, or moderately rough with granules and wrinkles and warts or small tubercles scattered over the entire upper surface and sides of head and body. Parotoid gland not developed, but may be made out as a glandular postocular ridge descending along the side of the neck. A larger elongate gland or series of smaller glands on side of body. Vomerine teeth in two small round patches between the anterior part or middle of the choanæ and about equidistant from the internal edges of these openings and from each other. Tongue large, very broadly attached, but slightly free all around its edge. Fingers long, slender, obtusely pointed; first shortest, third longest second and fourth equal; three pads on lower surface of carpus, a very large inner one and a small one on the base of each of the two outer metacarpals. Hind limbs moderately long, tibio-tarsal joint reaching eye. Toes rather slender, except outer, which is wide and flat; webs short, but edging toes for some distance; no subdigital tubercles. In adult males a "tail" (absent in females) extends back six or eight millimeters from the posterior surface of the thighs, is about four millimeters wide, and about three and one-half deep at its base. The cloaca is continued from its usual position into this structure, and ends in a large swollen orifice just in front and below the tip of the "tail".

Color in alcoholic specimens above reddish-brown or dark gray, clouded with black. A light stripe extends across top of head between anterior points of orbits. A black stripe interrupted by the orbit extends from nostril to posterior part of parotoid region.

Upper surfaces of front limbs striped with black. Posterior edge of tibia bounded by a black line narrowly edged with yellowish-white. Under surfaces yellowish.

Mrs. Gaige writes: "In live specimens there is a considerable range of color variation which is rather difficult to describe. The following color notes [Ridgway's Color Code] were made on a live female: back cacao brown, light spot on head pinkish cinnamon, warts on sides and legs cinnamon buff, sides of head and body dark olive buff, below flesh color which was most distinct on chin and legs, belly densely spotted with mustard yellow. A live male differed from the female in having a citrine drab back and the warts cacao brown; the 'tail' above was the color of the body with a dark stripe down either side, beneath darker. The ground color is most commonly old rose or brick red, but it may vary from cream white, through various shades of pink, gray, and brown to almost black. In the lightest and darkest specimens the pattern is fairly well obscured. The glandular ridge or row of glandules on the side is usually dark tipped with golden yellow; the dark spot on the head is almost triangular; the dark line on the wrist is seldom interrupted; the upper surface of the limbs is often set off from the lower by a dark line which merges gradually into the color beneath. The females are usually more brightly colored than the males."

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Sex	♂	♂	♂	♀	♀	♀
Snout to anus	41	37	37	40	38	39
Snout to base of "tail"	38	36	34			
Length of "tail"	7	5	7			
Width of head	15	14	9	15	15	15
Diameter of eye	4	3	3	4	3	3
Interorbital width	4	4	5	4	5	3
Snout to orbit	7	6	7	7	6	7
Nostril to orbit	4	3	4	3	3	3
Fore limb	23	24	20	21	20	22
Hind limb	60	55	58	59	60	55
Length of foot	9	12	14	14	15	15

Habits.—The following is from my note book of the summer of 1911: On August 16 and 17, I took three specimens of Ascaphus on the southwest side of Mount Rainier, in what is known as Indian Henry's Hunting Grounds, at about 6,000 feet elevation. All three were found on bright sunny mornings between 10:30 and noon, in a small slow-flowing stream. The one first taken jumped out of the brush into a small pool about four feet wide, five or six feet long, and two or three feet deep. It swam for a few seconds, just as a toad does; and when I attempted to catch it with my forceps, it went to the bottom and settled just like a frog, remaining perfectly motionless, its color blending with the color of the rocks and earth at the bottom of the pool. The second one I noticed in the same place, and I first saw it swimming about the middle of the pool just as I stepped down on the bank. While I was attempting to capture this individual a third one jumped into the pool from the bank directly opposite me and went straight to the bottom. I collected both of these, but a careful search and beating of brush in the vicinity failed to discover any more. All three were kept in a tin can, well punctured for ventilation, but they died within ten or twelve hours after capture.

A letter from Mr. Phillip Putnam, dated August 29, 1921, says: "When I went up the Skokomish River, I expected to get a lot of *Ascaphus*, but my first day's collecting yielded me only two specimens. I was at a loss to understand such poor luck, but a few days before we had a heavy rain, sopping the forests so that they reeked with water. I thought that the frogs might have forsaken the creek for the wet mossy soil. Further examination showed that the *Ascaphus* had left the creeks and were wandering about on land. I found four away from the water, one of which had not begun to absorb the tail, and was over 100 feet from the water. However, to collect the frogs in the forest was very difficult, as it was too much like looking for a 'needle in a hay stack'. I have always had the best luck collecting during a long dry spell. Now I know the reason to be that when it is wet, what few of them there are leave the water. and during a dry spell, lack of moisture forces them back again to the water."

Distribution.—Ascaphus truei has been found in Washington, Oregon, and California.

In Washington, it has been taken in King (at 2,000 feet in the Cascade Mountains near North Bend), Pierce (Mount Rainier in Paradise Valley and at 6,000 feet in Indian Henry's Hunting Grounds), Jefferson (Mount Steele), Mason (vicinity of Lake Cushman, Mount Rose, Olympic Mountains, Laundry Creek, Big Log Ranger Station, McTaggart Creek, Mount Ellinor Creek, Skokomish River Valley), and Chehalis (Humptulips), counties.

In Oregon, it has been secured at 3,000 feet, on Red Creek, in the Santiam National Forest, Linn County.

The only California record is of a specimen in the U. S. National Museum, caught at 5,000 feet altitude, on Craggy Peak, Siskiyou Mountains, Siskiyou County.

Suborder III. LINGUATA

It is to this suborder that most of the tailless amphibians belong. Those of western North America are referred to four families which include respectively the spade-foot toads, the true toads, the tree toads, and the frogs.

Family 5. SCAPHIOPODIDÆ

The members of this family have no ribs. The sternum is archiferous. The vertebræ usually are procœlous. Teeth are present in the upper jaw. The tongue is rounded, slightly notched and free behind. The pupil is vertically eliptic. A single genus represents this family in North America.

Genus 11. Scaphiopus

Scaphiopus HOLBROOK, N. Amer. Herpetology, Ed. 1, I, 1836, p. 85 (type, *solitarius=holbrooki*).

Spea COPE, Journ. Acad. Nat. Sci. Phila., Ser. 2, VI, 1866, p. 81 (type, *Scaphiopus bombifrons*).

In this genus the skin may be smooth or roughened with tubercles. Parotoids may be present but are lacking in our western species. The toes are extensively webbed. The vertebræ are procœlous. The sacrum and coccyx are united. The metatarsum is a cartilaginous plate. There is a large metatarsal, horny scraper or shovel.

SYNOPSIS OF SPECIES

a.—Smaller; snout more truncate in profile: often with two or four light, longitudinal, dorsal bands on a darker ground. .... **S. hammondii.**—p. 84

a.^{2}—Larger; snout rounded in profile: color dark; more rugose. usually reticulated with black.......................**S. couchii.**—p. 87

Scaphiopus hammondii Baird

Western Spadefoot

Plate 11, figure 2

Scaphiopus hammondii Baird, Rep. Pac. R. R. Surv., X, 1859, Pt. IV, No. 4, p. 12, pl. 28, figs. 2a-2d (type locality, **Fort Reading, California**); Cope, Proc. Acad. Nat. Sci. Phila., 1863, p. 53; Cooper, *in* Cronise, Natural Wealth Calif., 1868, p. 486; Cooper, Proc. Calif. Acad. Sci., IV, 1870, p. 64; Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 12; Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 435; Stejneger, N. Amer. Fauna, No. 7, 1893, p. 222; Dickerson, Frog Book, 1906, p. 59; Ellis & Henderson, Univ. Colo. Stud., X, No. 2, 1913, pp. 51, 121; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, p. 392; Ruthven & Gaige, Occas. Papers Mus. Zool. Univ. Mich., No. 8, 1915, pp. 11, 15; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 102; Strecker, Baylor Bull., XVIII, No. 4, 1915, p. 54; Stejneger & Barbour, Check List. N. Amer. Amph. Rept.. 1917, p. 25; Stephens, Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 59; Schmidt, Bull. Amer. Mus. Nat. Hist., XLVI, 1922, pp. 612, 615, 617, 630, 633; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 23; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 148.

Scaphiopus bombifrons Cope, Proc. Acad. Nat. Sci. Phila., 1863, p. 53 (type locality, **Fort Union on Missouri River, Lat. 48° N.**); Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 435.

Spea hammondii Cope, Journ. Acad. Nat. Sci. Phila., Ser. 2, VI, 1866, p. 81; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 301; Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 31; Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 14; Stejneger, N. Amer. Fauna, No. 3, 1890, p. 117.

Spea bombifrons Cope, Journ. Acad. Nat. Sci. Phila., Ser. 2, VI, 1866, p. 81; Cope, Amer. Nat., VIII, 1879, p. 437.

Spea hammondi Coues, Surv. W. 100th Merid., V, 1875, p. 630; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 177, 193; Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 32; Stone, Proc. Acad. Nat. Sci. Phila., 1911, p. 223.

Scaphiopus couchii Yarrow, Surv. W. 100th Merid., V, 1875, p. 526; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 117 (part).

Scaphiopus couchii varius Yarrow, Surv. W. 100th Merid., V, 1875, p. 526; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 177 (part).

Spea stagnalis Cope, Yarrow, Surv. W. 100th Merid., V, 1875, p. 525, pl. XXV, figs. 6-8 (type locality, **Alto dos Utas, Northwest New Mexico**); Yarrow & Henshaw, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., App. NN, 1878, p. 209; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 177.

Scaphiopus dugesi Brocchi, Bull. Soc. Philom., Ser. 7, III, 1879, p. 23 (type locality, **Guanajuato, Mexico**); Brocchi, Miss. Sci.

Mex., Batrach., 1881, p. 94, pl. 9, fig. 4; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 436.

Scaphiopus stagnalis BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 436.

Scaphiopus intermontanus COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 15, 18 (type locality, **Salt Lake City** and **Pyramid Lake, Nevada**).

Scaphiopus varius varius YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 177 (part).

Spea hammondii bombifrons COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 306.

Spea hammondii intermontana COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 304, fig. 76; COPE, Proc. Acad. Nat. Sci. Phila., 1893, pp. 182, 184; DICKERSON, Frog Book, 1906, p. 59 (footnote).

Spea hammondii hammondii COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 305, fig. 77, pls. XLVI, fig. 8, XLIX, fig. 18, LXVI, fig. 1.

Scaphiopus hammondii hammondii GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 140; Dice, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 300, 301, 304; GRINNELL & STORER, Animal Life in the Yosemite, 1924, p. 654.

Scaphiopus hammondi hammondi ENGLEHARDT, Copeia, 1918, No. 60, p. 77.

Scaphiopus SNYDER, Copeia, 1920, No. 86, p. 83.

Scaphiopus hammondi CARY, N. Amer. Fauna, No. 33, 1911, p. 27; TAYLOR, Univ. Calif. Publ. Zool., VII, No. 10, 1912, p. 345; PRATT, Verteb. Animals of the U. S., 1923, p. 169.

Description.—Head broader than long, rounded or bluntly oval in outline from above. Snout slightly overhanging or may be perpendicular in profile. Canthus rostralis absent. Nostril a little nearer to tip of snout than to orbit; distance between nostrils greater than interorbital width; interorbital width less than width of upper eyelid. Tympanum rather indistinct, oval in outline, about half diameter of eye. No parotoid gland. Fore limbs moderately heavy, with one or two palmar tubercles; third finger longest, second and third about equal; tips lightly enlarged; webs short, extended along edges of second finger: femur longer than tibia; under surfaces of feet smooth, with web extending along sides of fourth toe. Metatarsal tubercle on inner edge of foot greatly enlarged, with a free and sharp edge. Tongue large, free and slightly notched behind, lateral borders free. Vomerine teeth in two small patches between the choanæ, separated medially by the length of a single patch. Skin somewhat smooth, dorsal and lateral surfaces covered with small roundish tubercles. Under surfaces granular, back of thigh with minute tubercles.

Dorsal coloring in alcohol gray, with two or four longitudinal silvery-gray stripes reaching from back of head to thighs. Anterior parts of dorsal surface clouded or mottled with black. Under surfaces yellow or yellowish-white, gular region clouded with dark gray.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	50	53	56	58	59	62
Width of head	22	22	22	25	23	28
Diameter of eye	5	5	5	5	5	5
Interorbital width	4	4	5	4	4	4
Snout to orbit	6	8	9	7	7	7
Nostril to orbit	4	4	5	4	4	5
Fore limb	30	30	27	29	27	32
Hind limb	64	64	65	63	67	73
Length of foot	23	22	22	23	25	27

Habits.—This is one of the most secretive of our western batrachians and is generally found only during the breeding season. After the first heavy rains these toads gather in the pools of rain-water on the desert floor, where they can be heard croaking vigorously far into the night. The writer found them in early July along the banks of Pyramid Lake, Nevada, where they were much in evidence for only two nights and then disappeared completely. The species is no doubt quite abundant but owing to the secretive habits it is necessary to be on the spot just at the proper time in order to secure specimens.

Distribution.—This spadefoot occurs in all of the states west of the Rocky Mountains ranging thence eastward to Montana and Texas and south into Mexico.

In Washington, it probably is confined to the region east of the Cascade Mountains, where it has been taken in Chelan (Chelan), Yakima (Mabton, Sunnyside), Walla Walla (Fort Walla Walla, Wallula), and Lincoln (Sprague), counties.

In Oregon, it has been found in Jefferson (Warm Springs), Crook (Prineville), Harney (Harney), and Baker (Home), counties.

In Idaho, it is fairly common in Ada (Boise) County.

In Nevada, specimens have been caught in Washoe (Pyramid Lake), Humboldt (Thousand Creek Hot Springs, Virgin Valley, Big Creek at base of Pine Forest Mountains, Quinn River Crossing), Lincoln (Bunkerville), and Elko (Carlin), counties.

In Utah this species is known from Salt Lake (Salt Lake City, Fort Douglas), Utah (Provo, Payson), Beaver (Beaver), and Washington (Bellevue, St. George, Grapevine Springs at 3,000 feet eight miles south of Bellevue) counties, and from Zion National Park.

Arizona records are based upon specimens from the Painted Desert and St. Thomas.

In California, it has been secured in Shasta (Fort Reading near Redding), Fresno (Lane's Bridge), Tulare (Tipton, Earlimart), San Luis Obispo (Simmler), Mono (Mono Lake at Salmon Ranch and Farrington's, Benton, Convict Creek, Long Valley), Inyo (Olancha at 3,700 feet), Santa Barbara (Betteravia, Santa Barbara, Santa Maria), Los Angeles (Sierra Madre, Los Angeles), and San Diego (San Diego, and three miles west from Bonsall on the San Luis Rey River), counties.

Scaphiopus couchii Baird

SONORAN SPADEFOOT

Scaphiopus couchii BAIRD, Proc. Acad. Nat. Sci. Phila., VII, 1854 (1855) p. 62 (type locality, **Rio Nasas, Coahuila and Matamoros, Tamaulipas, Mexico**); BAIRD, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 28, pl. 35, figs. 1-6; COPE, Proc. Acad. Nat. Sci. Phila., 1863, p. 52; BAIRD, Proc. Acad. Nat. Sci. Phila., 1864, p. 62; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 32; BROCCHI, Miss. Sci. Mex., Batrach., Pt. 3, Sec. 2, 1882, p. 26; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 434; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 301, fig. 75, pl. LXVIII, fig. 2; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 558; MOCQUARD, Nouv. Arch. du Mus. Hist. Nat. Paris, Ser. 4, I, 1899, p. 342, pl. XIII, fig. 6; DICKERSON, Frog Book, 1906, p. 57, pl. VIII; RUTHVEN, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 503; STRECKER, Proc. Biol. Soc. Wash., XXI, 1908, p. 199; STRECKER, Baylor Univ. Bull., XII, No. 1, 1909, p. 9; STRECKER, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 80; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 395; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 25; NELSON, Mem. Nat. Acad. Sci., XVI, 1921, p. 113; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 620, 621, 628, 630, 633; PRATT, Verteb. Animals of the U. S., 1923, p. 169; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 22; STRECKER, Contrib. Baylor Univ. Mus., No. 8, 1926, p. 11.

Scaphiopus varius COPE, Proc. Acad. Nat. Sci. Phila., 1863, p. 52 (type locality, **Cape St. Lucas, Lower California**); BROCCHI, Miss. Sci. Mex., Batrach., 1881, p. 27.

? *Scaphiopus rectifrenis* COPE, Proc. Acad. Nat. Sci. Phila., 1863, p. 53 (type locality, **Tamaulipas, Coahuila**); BROCCHI, Miss.

Sci. Mex., Batrach., 1881, p. 27; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 435.

Scaphiopus couchii (var. varius) COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 313.

Scaphiopus varius varius COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 31; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 177 (part).

Scaphiopus varius rectifrenis COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 32; YARROW, Bull, U. S. Nat. Mus., No. 24, 1883, p. 193.

Scaphiopus couchi YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 177 (part); BELDING, W. Amer. Scientist, III, No. 24, 1887, p. 99.

Scaphiopus couchii varius GARMAN, Bull. Essex Inst., XVI, No. 1, 1884, p. 46; COPE, Bull. U. S. Nat. Mus., No. 32, 1887, p. 12; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, fig. 75.

Description.—Head about as broad as long, rounded in outline from above. Snout overhanging in profile. Nostrils directed upwards, nearer to tip of snout than to orbit: distance between nostrils less than interorbital width; interorbital width less than width of upper eyelid. Tympanum indistinct, oval in outline. about half the diameter of the eye. Parotoid glands obscure, covered with small tubercles. Fore limbs heavy. with one or two indistinct palmar tubercles: third finger longest, second and fourth about equal; tips with small knobs; fingers without webs. Femur longer than tibia; under surfaces of feet smooth. toes fully webbed. Metatarsal tubercle on inner edge of foot greatly enlarged. with a free and sharp edge. Tongue large, free and slightly notched behind, lateral borders free. Vomerine teeth in two small patches between the choanæ. Skin covered with small tubercles, more numerous on sides; under surfaces fairly smooth, back of thigh with minute tubercles.

Dorsal coloring in alcohol olive, or brownish, spotted or mottled with black. These black markings sometimes form into indistinct bands. Back of limbs yellowish, sparsely spotted with black. Under surfaces yellowish or brownish, without markings.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	59	60	61	62	63	64
Width of head	24	24	24	25	26	23
Diameter of eye	6	6	7	7	7	6
Interorbital width	6	5	6	5	6	6
Snout to orbit	10	10	10	9	10	10
Nostril to orbit	6	6	6	6	6	5
Fore limb	34	31	34	31	34	31
Hind limb	70	77	76	73	67	70
Length of foot	27	28	30	26	26	30

Habits.—The habits of this spadefoot are similar to those of *Scaphiopus hammondii.* In the spring of 1919, while the writer was on a trip from La Paz to San Jose del Cabo, Lower California, Mexico, a halt was made to rest the pack animals and to take shelter from an approaching thunder storm. During the storm the road became a rushing river, which however, quickly dried when the rain had passed, leaving a few puddles in the depressions. As if by magic these became filled with spadefoot toads till several hundred had congregated in two or three of the pools. These particular puddles were visited the next day and until they had dried up, but the toads never appeared again.

Distribution.—*Scaphiopus couchii* ranges from Texas to Arizona south into Mexico. It is common in the Cape Region of Lower California.

In Arizona, it has been collected in Cochise (Willcox, Fairbank), and Pima (Tucson, Roebles Ranch near Coyote Springs between Tucson and the Baboquivari Mountains) counties.

In Sonora, it has been taken at Nogales.

In Lower California, it has been secured at Cape San Lucas, San Jose del Cabo, Miraflores between La Paz and San Pedro, La Paz, Mulege, and San Ignacio.

Family 6. BUFONIDÆ

In this family the vertebræ are procœlus and without ribs; the sternum is usually a cartilaginous plate; the frontoparietals are completely ossified; the pterygoid bone is absent.

Genus 12. Bufo

Bufo LAURENTI, Syn. Rept., 1768, p. 25 (type, *vulgaris*=*bufo*).

In this genus, the only one represented within the limits of this work, the pupil may be round or horizontal. The parotoid glands are always present. The skin is usually rough, covered with warts. The vomers are without teeth.

SYNOPSIS OF SPECIES AND SUBSPECIES

- a.—Cranial crests absent or obscure.
  - b.—Cranial crests absent.
    - c.—Parotoid glands widely separated; size larger.
      - d.—Parotoid glands roundish, sole tubercles smaller.

e.—Snout longer; skin rough, with various sized warts .... *B. b. boreas*.—p. 90

e.—Snout shorter; skin between warts smoother; warts smaller............................ ....*B. b. halophilus*. —p. 94

d.—Parotoid glands long, oblique; sole tubercles larger .... **B. compactilis**.—p. 97

c^2.—Parotoid glands nearly meeting on midline; size smaller ....**B. canorus**.—p. 99

b^2.—Crests obscure, sometimes absent; size small; dorsal surfaces covered with small roundish warts............................ .. ..**B. punctatus**.—p. 100

a^2.—Cranial crests present.

bb.—Size smaller; crests not forming curve around the orbits.

cc.—Crests forming an angle at posterior end of orbit, extending laterally to tympanum. ..**B. woodhousii**.—p. 102

cc^2.—Crests straight and narrow.

dd.—Size larger; large sole tubercle present with free cutting edge........................ ....**B. c. cognatus**.—p. 105

dd^2.—Size smaller; inner sole tubercle not developed, terminating in a horny point....**B. c. californicus**.—p. 107

bb^2.—Size very large; crests forming a curve around the orbits ....**B. alvarius**.—p. 108

Bufo boreas boreas Baird & Girard

NORTHWESTERN TOAD

Plate 12

Bufo boreas BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 174 (type locality, Columbia River and Puget Sound); GIRARD, U. S. Explor. Exped., Herpet., 1858, p. 74, pl. 6, figs. 4-9; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 296, fig. (part); VAN DENBURGH, Proc. Amer. Philos. Soc., XXXVII 1898, p. 139; DICKERSON, Frog Book, 1906, p. 115, pl. XLIV; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; TAYLOR, Univ. Calif. Publ. Zool., VII, No. 10, 1912, p. 343; ELLIS & HENDERSON, Univ. Colorado Studies, X, No. 2, 1913, pp. 49, 121; ELLIS & HENDERSON, Univ. Colorado Bull., XV, No. 6, 1915, p. 254; RUTHVEN & GAIGE, Occas. Papers Mus. Zool. Univ. Michigan, No. 8, 1915, pp. 11, 13; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 101.

Bufo columbiensis BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., 1853, p. 378 (type locality, Columbia River, Oregon); GIRARD, U. S. Explor. Exped., Herpt., 1858, p. 77, pl. 5, figs. 4-9; BAIRD, Rep. Pac. R. R. Surv., X, 1859, Pt. IV, No. 4, p. 12; COPE, Ann.

Rep. U. S. Geol. Surv. Terr., 1871, (1872), p. 468; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 163; COPE, Proc. Acad. Nat. Sci. Phila., 1893, pp. 181, 184; VAN DENBURGH, Bull. U. S. Fish Commission for 1894, p. 207; YOUNG, Proc. Acad. Nat. Sci. Phila., 1909, p. 298; DICE, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 309, 319.

Bufo microscaphus COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 301 (type locality, the Upper Colorado River Region); COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 522; YARROW, Surv. W. 100th Merid., V, 1875, p. 522 (part); COUES, Bull. U. S. Nat. Mus., No. 24, 1883, p. 163.

Bufo pictus COPE, *in* YARROW, Surv. W. 100th Merid., V, 1875, p. 522, pl. XXV, figs. 4, 5 (no locality); YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 164, 193; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 270.

Bufo halophilus YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., App. NN, 1878, p. 208 (part); BOULENGER, Cat. Batrach. Salient. Brit Mus., 1882, p. 295, fig. (part); COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 23, 25; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 162 (part).

Bufo columbiensis columbiensis COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 269, fig. 63.

Bufo boreas boreas CAMP, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 115, 116; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 143; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept.. 1917, p. 27; BLANCHARD, Copeia, 1921, No. 90, p. 6; PATCH, Copeia, 1922, No. 111, p. 76; PRATT, Verteb. Animals of the U. S., 1923, p. 174; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 24; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 167; HARDY, Rep. Prov. Mus. Brit. Columbia, 1925, p. c23.

Description.—Size large; cranial crests absent. Head much broader than long. oval in outline from above. Snout vertical in profile. Nostril small, directed downwards, nearer to tip of snout than to orbit; distance between nostrils less than interorbital width; interorbital width about twice that of upper eyelid. Tympanum small. vertical and oval in outline; surface smooth. Parotoid glands roundish, moderately large; separated by one and one-half times their length. Limbs robust; a well developed inner sole tubercle; two well developed palmar tubercles: fingers and toes with small round knob-like ends; small roundish subarticular tubercles present. Skin rugose, thickly covered with small roundish and elongate warts on the back and on the thighs. Under surfaces granular, with minute tubercles on the backs of the thighs. Tongue narrow, oval in outline, attached centrally and anteriorly.

Dorsal ground color in alcohol olive, brownish, or greenish. The numerous warts of the dorsal surface are brownish or reddish-brown, bordered with black. A yellowish middorsal stripe extends from tip of snout to anus; lateral surfaces spotted or reticulated with black. Under surfaces brownish or yellowish, sparsely spotted with black. Under surfaces of feet, and tips of fingers and toes, are brown or reddish-brown.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	77	86	90	91	98	99
Width of head	32	36	37	40	41	40
Diameter of eye	6	5	8	7	8	7
Interorbital width	6	8	9	8	9	7
Snout to orbit	10	8	12	11	11	7
Nostril to orbit	6	5	8	7	6	4
Fore limb	58	63	52	57	60	58
Hind limb	110	117	112	112	120	110
Length of foot	95	64	60	65	72	60
Breadth of foot	30	32	30	35	26	33

Habits.—Similar to *B. b. halophilus.*

Distribution.—This toad ranges from Alaska to northern California and east through Idaho and northern Nevada to Utah and Colorado.

In Alaska it has been collected, in the Prince William Sound Region: "in a large lake near Prince William's Sound"; at Cordova Bay; at Canoe Passage, Hawkins Island; and on Montague Island; in the Sitkan region, at Thomas Bay, and on Swan, Admiralty, and Heceta islands, and on Sergief Island at the mouth of the Stikine River: at Yakutat, and at Glacier Bay.

In British Columbia, it has been secured on the Queen Charlotte Islands at Masset and at Clew; on Vancouver Island at the North Pacific Coal Mines, Goldstream, and at Hall's Ranch, Alberni Valley; on Gabriola Island; and on the mainland near Atlin, four miles north from Telegraph Creek, Stikine River at Doch-da-on Creek, Bear Lake, Moose Lake, head of Moose River, North Fork of Moose River, Glacier, Field, Okanagan, Vancouver, Fraser River, Sumas Prairies, Chilliwack Lake, Bella Coola, Namu, Clinton, Meadow Lake 20 miles north from Clinton, and Watson Lake 45 miles north from Clinton.

Washington localities are Clallam (Cape Flattery, Lake Crescent, Forks, Soleduck River), Jefferson (Hoh River near Fischer's

Ranch, near Spruce), Kitsap (Gorse Creek), Mason (Lake Cushman, Mount Ellinor), Pacific (Shoalwater Bay), Whatcom (Semiahmoo Bay, Glacier, Nooksak River), San Juan (Orcas Islands, Friday Harbor), Pierce (five miles east from Tacoma, Fairfax, Mount Rainier), Clark (Vancouver), Skamainia (Mount Adams, Carson), Okanogan (Loomis, Hidden Lake), Chelan (Stehekin at head of Lake Chelan, Entiat), Yakima (Bumping Lake), Stevens (Colville, Springdale), Whitman (Pullman), Walla Walla (Fort Walla Walla), Columbia (Humpeg Falls, Blue Mountains), and Asotin (Anatone, Grand Ronde River), counties.

In Oregon, it has been taken in Multnomah (Portland), Clackamas (Oregon City), Coos (Empire), Douglas (Roseburg, Fort Umpqua), Josephine (Grants Pass), Jackson (Siskiyou at 4,100 feet), Hood River (Hood River), Crook (Prineville), Klamath (Fort Klamath, Klamath Falls, Merrill), Lake (Chewaucan Valley, Warner Lakes), Umatilla (Meacham, Umatilla), and Wallowa (Wallowa Lake, Wallowa Canyon), counties.

In California this toad intergrades with the southern subspecies, *Bufo boreas halophilus*. No definite limits to the area occupied by each are apparent, for individual variation is very great. Mr. Camp states that *B. b. boreas* ranges south to Eureka, Humboldt County, Sisson, Siskiyou County, and Modoc County, and *B. b. halophilus* north to the Gualala River, Mendocino County, Oroville, Butte County, and Independence, Inyo County, the intervening area being that of intergradation. For convenience, the toads of the seven northern counties will be here referred to *B. b. boreas*, while those from elsewhere in California are regarded as *B. b. halophilus*. Toads seem not to have been taken in Trinity and Lassen counties, but have been secured in Del Norte (Crescent City), Humboldt (Eureka), Siskiyou (Mount Shasta, Butte Creek, Sisson), Modoc (Fort Bidwell, Upper Pit River, Goose Lake Meadows near Sugar Hill, South Fork of Pit River near Alturas, Parker Creek in the Warner Mountains, head of North Fork of Parker Creek, mouth of Dry Creek in the Warner Mountains, east face of Warren Peak at 8,700 feet, Warner Mountains), and Shasta (Fort Crook, Baird, McCloud) counties.

In Nevada this toad has been recorded from Washoe (Pyramid Lake at Sutcliffe, the Pyramids and Anaho Island), Humboldt (Quinn River Crossing, head of Alder Creek, and in the Pine Forest Mountains at Big Creek Ranch and Leonard Creek), Lander (Austin), and Elko (Elko, Wells, Upper Humboldt Valley, Mountain City) counties.

In Idaho, it has been taken in Bonner (Clark's Fork, Lower Kootenai River), Kootenai (Blue Lake, Mount Carlton), Valley (Payette Lake, McCall), Ada (Boise), Elmore (Atlanta), Custer (Alturas Lake, Sawtooth), Jerome (between Blue Lakes and Shoshone Falls), Bannock (Mink Creek near Pocatello), and Bear Lake (Deep Lakes, Bloomington Canyon), counties.

Utah counties from which this toad are known are Salt Lake (Salt Lake City, Fort Douglas), Summit (Kimballs near Park City), Utah (Provo, Utah Lake), Wasatch (Wasatch Mountains at 8,728 feet near the head of Big Cottonwood Canyon, and in Little Cottonwood and Provo canyons), and Juab (Juab), counties.

Bufo boreas halophilus Baird & Girard

CALIFORNIA TOAD

Plate 13

Bufo halophilus BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1853, p. 301 (type locality, Benicia, California); GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 87; BAIRD, U. S. Mex. Bound. Surv., II, Rept., 1859, p. 26, pl. 41, figs. 7-12; COOPER, Proc. Calif. Acad. Sci., IV, 1870, p. 64.

Bufo chilensis GÜNTHER, Cat. Batrach. Salient. Brit. Mus., 1858, p. 56 (part).

Bufo halophilus COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., Append. NN, 1878, p. 208; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 295, fig. (part); YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 162 (part); TOWNSEND, Proc. U. S. Nat. Mus., X, 1887, p. 241; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 220; DICKERSON, Frog Book, 1906, p. 113, pls. XLI, XLII, XLIII; HURTER, First Ann. Rep. Laguna Marine Lab., 1912, p. 67; STORER, U. C. Journ. Agric., II, No. 3, 1912, pp. 88-91; RUTHLING, Lorquinia, Vol. I, No. 1, 1916, p. 6.

Bufo boreas BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 296, fig. (part).

Bufo columbiensis COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 32; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, pp. 133, 138.

Bufo columbiensis halophilus COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 269, fig. 64.

Bufo boreas nelsoni STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 220, pl. 3, figs. 4a, 4b (type locality, Oasis Valley, Nye County, Nevada); DICKERSON, Frog Book, 1906, p. 116; CAMP, Univ. Calif. Publ. Zool., XVII, 1917, pp. 115, 117; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 143.

Bufo boreas halophilus CAMP, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, p. 116; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 142; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 27; NELSON, Mem. Nat. Acad.

Sci., XVI, 1921, p. 113; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 615, 629, 634; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 24; PRATT, Verteb. Animals of the U. S., 1923, p. 174; GRINNELL & STORER, Animal Life in the Yosemite, 1924, pp. 655-657, pl. 60a; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 169.

Bufo borealis halophilus STEPHENS, Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 60.

Description.—Size large; head a little broader than long, rounded in outline from above. Snout broadly truncate, overhanging in profile. Nostril horizontal or directed slightly downward, nearer to tip of snout than to orbit; distance between nostrils less than interorbital width; interorbital width equal to or very little greater than width of upper eyelid. Tympanum small, broadly oval or roundish in outline. Canthus rostralis moderately prominent or obscure. Parotoid glands well developed, elongate or sometimes roundish in outline. Limbs robust; a prominent inner sole tubercle; two large palmar tubercles; under surfaces of feet with minute tubercles; subarticular tubercles prominent; fingers and toes with rounded knob-like ends. Skin smooth; back and dorsal surface of hind limbs with widely scattered roundish or elongate warts. Under surfaces granular, with small tubercles on thighs. Tongue narrow, oval in outline, attached centrally and anteriorly.

Ground color above grayish or greenish, spotted or reticulated with black. Warts on back may be with or without black borders. A narrow yellowish dorsal stripe extends from tip of snout to anus. Under surfaces yellowish, sparsely spotted with black. Some individuals are uniform yellowish without the black markings.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	72	77	78	82	86	93
Width of head	30	33	32	35	32	35
Diameter of eye	8	10	10	10	11	10
Interorbital width	7	6	5	8	6	7
Snout to orbit	12	12	12	12	11	9
Nostril to orbit	6	6	5	7	7	7
Fore limb	50	47	38	49	42	47
Hind limb	90	83	95	101	99	97
Length of foot	48	46	54	55	51	57
Breadth of foot	18	21	25	28	30	27

Habits.—This species is common throughout its range. It usually inhabits flower gardens, roads or sheltered paths, where it can be found feeding shortly after dark. Its food consists principally of insects, and consequently *Bufo b. halophilus* is of considerable economic value, as it destroys many destructive beetles and other insect pests. In the daytime it hides under boards, in small burrows under stones, piles of debris, and under houses where it can be sheltered from full daylight.

Distribution.—This subspecies ranges from northern Lower California north to western Nevada and northern California, where intergradation with *Bufo boreas boreas* is said to occur between the thirty-ninth and fortieth parallels of latitude.

In Lower California, it has been collected at Ensenada, La Grulla, and in the San Pedro Martir Mountains.

In Nevada, it has been secured in Storey (Virginia City), Ormsby (Carson City), Douglas (Glenbrook), and Nye (Oasis Valley), counties.

In California, it has been taken in San Diego (San Diego, La Puerta, Vallecito, Jacumba Hot Springs, Cuyamaca Mountains, Mountain Springs, Buckman Springs, Lakeside, Barrett Dam, Cottonwood, Campo, San Felipe Valley), Riverside (Palm Springs, Banning, Cabazon, Reche Canyon, San Jacinto Valley, San Jacinto Mountains at Kenworthy, Round Valley, Tahquitz Valley and Strawberry Valley), San Bernardino (in the San Bernardino Mountains at Dry Lake and Doble, Victorville), Los Angeles (Los Angeles, Hollywood, Glendale, Lankershim, Altadena, Sierra Madre, one-half mile south from El Monte, Arroyo Seco near Pasadena, Antelope Valley, Lancaster, Elizabeth Lake at 3,317 feet), Ventura (Santa Paula), Santa Barbara (Santa Barbara), San Luis Obispo (Simmler, Carrizo Plains, Santa Margarita, Morro), Kern (Fort Tejon, San Emigdio Creek, Walker Basin, west side Walker Pass, Weldon, Kern River at Isabella, Onyx), Inyo, (Laws, Kearsarge Pass, Independence, Alvord at 4,000 feet, Bishop Creek at 4,000 feet, Independence Creek at 6,000 feet, Lone Pine, Lone Pine Creek, White Mountains, Resting Springs, Owen's Valley at Moran's at 5,000 feet), Mono (Farrington's, Walker Lake, Benton), El Dorado (Lake Tahoe), Tulare (Earlimart, Whitney Meadows at 9,371 feet, Round Valley at 10,000 feet, East Fork of Kaweah River at 10,200 feet, Monache Meadows, Cannell Meadows), Fresno (Fresno, Hume, Minkler, Mendota, King's River at 5,200 feet), Monterey (Monterey, Carmel), San Benito (Hollister, San Juan), Merced (Snelling, Gadwell), Madera (Madera), Mariposa (Pleasant Valley, floor of Yosemite Valley), Santa Clara (Coyote, San Jose, Los Gatos, Palo Alto, Stanford University), San Mateo (Redwood

City, San Mateo, Millbrae), San Francisco (Presidio, Golden Gate Park), Alameda (Haywards, Oakland), Contra Costa (two miles southwest from Walnut Creek, Lafayette), San Joaquin (Corral Hollow eight miles southeast from Tracy, Lathrop, Stockton), Marin (Sausalito, San Anselmo, San Rafael, Manor, Paper Mill Canyon near San Geronimo, divide at 800 feet between Mill Valley and Muir Woods), Sonoma (Monte Rio, Warm Springs Creek near Skaggs Springs, Cloverdale), Mendocino (Gualala, Ukiah, Cahto, Sherwood, three miles west from summit of Mt. Sanhedrin, four miles south from Covelo), Napa (Napa Junction, Calistoga), Solano (Benicia, two miles south from Vallejo, three miles west from Vacaville, Mare Island, four miles west from Dixon), Yolo (Rumsey, Grafton, Grand Island, Knights Landing, Davis), Sutter (Butte Slough near West Butte), and Butte (Chambers Ravine near Oroville), counties.

Bufo compactilis Wiegmann

SONORAN TOAD

Plate 14, figure 2

Bufo compactilis WIEGMANN, Isis von Oken, 1833, p. 661 (type locality, Mexico); PETERS, Monatsb. Berlin Akad., 1863, p. 89; PETERS, Monatsb. Berlin Akad., 1873, p. 624; COPE, Amer. Nat., XIII, 1879, p. 437; BOULENGER, Cat. Batrach. Salient., 1882, p. 302; BROCCHI, Miss. Sci. Mex., Batrach., Pt. 3, Sec. 2, 1882, p. 70; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 272, fig. 65; DICKERSON, Frog Book, 1906, p. 102, pls. XXXIII, XXXIV, fig. 1; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, p. 81; STRECKER, Proc. Biol. Soc. Wash., XXI, 1908, pp. 48, 56, 82; STRECKER, Baylor Univ. Bull., XII, No. 1, 1909, p. 9; STRECKER, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 80; STRECKER, Baylor Bull., XVIII, No. 4, 1915, p. 51; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 28; ENGLEHARDT, Copeia, 1918, No. 60, p. 78; PRATT, Verteb. Animals of the U. S., 1923, p. 173; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 25; STRECKER, Contrib. Baylor Univ. Mus., No. 6, 1926, p. 9.

Amaxyrus melancholicus TSCHUDI, Faun. Per., Herpt., 1846, p. 78.

? *Bufo speciosus* GIRARD, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 86 (type locality, Rio Bravo [=Rio Grand del Norte]); BAIRD, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 26, pl. 40, figs. 5-10; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 164.

Bufo anomalus GÜNTHER, Cat. Batrach. Salient. Brit. Mus., 1858, p. 57 (type locality, Mexico).

Bufo levifrons BOCOURT, Bull. Soc. Philom., Ser. 7, I, 1876, p. 187 (type locality, Mexico).

Dromoplectrus anomalus CAMERANO, Atti Acc. Tor., XIV, 1879, p. 882.

Description.—Size small; cranial crests absent. Head broader than long; oval in outline from above; snout truncate, vertical in profile. Nostrils oval, oblique, terminal; distance between nostrils about equal to interorbital width; interorbital width equal to that of upper eyelid. Tympanum small, vertical, oval in outline. Parotoid glands distinct, short, oval in outline. Limbs delicate; both inner and outer sole tubercle with free edge; inner tubercle well developed; a single large palmar tubercle; minute subarticular tubercles present; fingers and toes delicate, with small knob-like ends. Skin very slightly granular, thickly covered with small roundish warts. Under surfaces granular. Tongue moderately large, roundish in outline, attached centrally and anteriorly.

Ground color above greenish or grayish, clouded, spotted or marbled, with dark-gray or black. Under surfaces yellowish; tips of fingers reddish or black. There is no well defined vertebral stripe, but some individuals show an obscure or interrupted one.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	43	47	51	54	56	58
Width of head	20	18	24	22	24	22
Diameter of eye	4	5	5	5	5	6
Interorbital width	4	4	5	4	5	5
Snout to orbit	5	4	6	6	5	6
Fore limb	27	26	34	32	30	36
Hind limb	58	59	69	65	65	71
Length of foot	29	30	34	36	35	35

Habits.—These toads were found about the flower gardens at Caliente, Lincoln County, Nevada.

Distribution.—This species ranges from northern Mexico and Texas west to Arizona and north to the southern portions of Utah and Nevada.

In Arizona, it has been collected in Yavapai (Prescott, Senator Mountains) and Mohave (Fort Mohave) counties.

In Nevada, it is common in Clark (Las Vegas) and Lincoln (Caliente) counties.

In Utah, this toad has been found in Washington (Saint George, Bellevue) County.

Bufo canorus Camp

YOSEMITE PARK TOAD

Plate 14, figure 1

Bufo canorus CAMP, Univ. Calif. Publ. Zool., XVII, No. 6, 1916, p. 59, figs. 1-4 (type locality, Porcupine Flat, 8,100 feet altitude, Yosemite National Park, Mariposa County, California); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 143; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 27; PRATT, Verteb. Animals of the U. S., 1923, p. 174; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 24; STORER, Univ. Calif. Publ. Zool, XXVII, 1925, p. 182.

Description.—Head a little broader than long, rounded in outline from above; snout slightly overhanging in profile. Limbs stout; inner and outer metatarsal tubercles moderately developed; one large and one small palmar tubercle. Parotoid glands well developed, circular in outline, separated on the midline by from two to four millimeters. Tongue narrow and oval, attached centrally and anteriorly. Skin smooth, dorsal surfaces covered with small rounded tubercles; backs of thighs with minute tubercles.

The ground color is greenish or brownish, the dorsal surfaces covered with reddish-brown tubercles surrounded by heavy black borders. The black color sometimes merges. forming reticulations, and is bordered by a narrow line of white. Some individuals have a narrow white dorsal stripe, reaching from the parotoid glands to the front of the thighs. The under surfaces are whitish or yellowish, with a few scattered black spots.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	56	59	65	70	70	75
Width of head	22	25	29	27	25	31
Diameter of eye	4	5	4	5	4	5
Interorbital width	2	2	4	2	4	3
Snout to orbit	7	9	9	10	10	9
Nostril to orbit	5	5	6	4	5	5
Fore limb	28	29	38	34	35	42
Hind limb	67	75	77	78	80	79
Length of foot	30	35	35	38	36	40
Breadth of foot	23	25	26	27	28	31

Habits.—Found in the vicinity of small streams and lakes in the mountain meadows of the high Sierras.

Distribution.—*Bufo canorus* is known only from the high central Sierra Nevada Mountains in the vicinity of Yosemite National

Park. Here it occurs in the Canadian and Hudsonian zones at altitudes of from 7,000 to 11,000 feet. It has been taken at Porcupine Flat at 8,100 feet; on Mount Conness Trail one mile west from Ragged Peak; one mile north of Peregoy Meadow; near Tamarack Flat; Tioga Lake, Mono County; near Mono Meadow; Vogelsang Lake, head of Dingley Creek; east fork Indian Canyon; at the head of Lyell Canyon; in Tuolumne Meadows, Dana Meadows, and at Lake Tenaya.

Bufo punctatus Baird & Girard

Red-spotted Toad

Bufo punctatus Baird & Girard, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 173 (type locality, **Rio San Pedro of the Rio Grande del Norte**); Hallowell, Sitgreaves' Exped. Zuni & Colorado Rivers, 1853, pp. 143, 147; Girard, Proc. Acad. Nat. Sci. Phila., 1854, p. 87; Baird, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 25, pl. 39, figs. 5-7; Heermann, Rep. Pac. R. R. Surv., X, 1859, p. 25; Cope, Proc. Acad. Nat. Sci. Phila., 1886, p. 313; Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; Yarrow, Surv. W. 100th Merid., V, 1875, p. 523; Cope, Bull. U. S. Nat. Mus., No. 17, 1880, pp. 4, 29, 46, 47; Brocchi, Miss. Sci. Mex., Batrach., Pt. 3, Sec. 2, 1882, p. 68; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 22, 162; Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 10; Belding, W. Amer. Scientist, III, No. 24, 1887, p. 99; Cope, Proc. U. S. Nat. Mus., XI, 1888, p. 395; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 262, fig. 60; Stejneger, N. Amer. Fauna, No. 7, 1893, p. 219; Van Denburgh, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 559; Cope, Amer. Naturalist, XXX, 1896, p. 1012; Stone & Rehn, Proc. Acad. Nat. Sci. Phila., 1903, p. 34; Dickerson, Frog Book, 1906, pp. 19, 110, color pl. V, fig. 1, pl. XL; Ruthven, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 507; Strecker, Proc. Biol. Soc. Wash., XXI, 1908, pp. 56, 82; Strecker, Baylor Univ. Bull., XII, No. 1, 1909, p. 9; Strecker, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 80; Stone, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 395; Strecker, Baylor Bull., XVIII, No. 4, 1915, p. 50; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, p. 100; Ellis & Henderson, Univ. Colorado Bull., XV, No. 6, 1915, p. 255, pl. II, figs. 8, 9; Englehardt, Copeia, 1917, No. 39, p. 5; Camp, Univ. Calif. Publ. Zool., XII, No. 17, 1916, p. 512; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 144; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 29; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 3, No. 4, 1921, p. 60; Nelson, Mem. Nat. Acad. Sci., XVI, 1921, p. 113; Schmidt, Bull. Amer. Mus. Nat. Hist., Vol. XLVI, Art. XI, 1922, pp. 612, 618, 620, 621, 629, 633; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 26; Pratt, Verteb. Animals of the U. S., 1923, p. 173; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 192.

Bufo beldingi Yarrow, Proc. U. S. Nat. Mus., 1882, p. 441 (type locality, La Paz, Lower California); Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 23, 163; Belding, W. Amer. Scientist, III, No. 24, 1887, p. 99.

Bufo coccifer Mocquard, Nouv. Arch. du Mus. Hist. Nat., Paris, Ser. 4, I, 1899, p. 334.

Description.—Size small; head much broader than long; triangular in outline from above; tip of snout flattened, overhanging in profile. Nostrils opening on tip of snout; distance between nostrils about half the interorbital width; interorbital width equal to that of upper eyelid. Tympanum small and round. Parotoid glands prominent, round in outline; canthus rostralis very prominent in adults. An obscure cranial crest extends along inner border of orbit. This crest may be scarcely visible in some individuals. Limbs moderate; inner and outer sole tubercles present; small round subarticular tubercles on fingers and toes; two well-developed palmar tubercles; under surfaces of feet granular. Tongue long and narrow, free laterally and posteriorly. Skin smooth, thickly spotted with small warts on back and thighs. Color in alcohol above grayish, spotted or reticulated with black. Numerous small reddish or orange warts on dorsal surface bordered with black. Limbs blotched or barred with black. Under surfaces yellowish or grayish, gular region sometimes clouded, spotted or marbled with darker gray.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	47	49	51	52	53	74
Width of head	19	20	20	21	20	26
Diameter of eye	5	5	5	6	5	7
Interorbital width	6	5	6	5	6	7
Snout to orbit	7	7	7	7	7	7
Fore limb	33	24	30	27	34	34
Hind limb	63	62	63	60	64	77
Length of foot	28	30	28	30	32	38

Habits.—This little toad was found by the writer to range from sea-level to about 1,400 feet. The following is from my note book while on a collecting trip in the Cape Region of Lower California: While collecting with a light early in the evening forty-six specimens were taken around the public square in the little village of San Antonio. They were heard calling late into the evening. A specimen captured was observed to make a shrill whistling noise of four or five seconds duration, at intervals of about the same length, the throat swelling considerably while it was doing so. The stomach of the one that was picked up dead contained the wing covers of several species of small beetles.

Distribution.—This toad ranges from Cape San Lucas north to southeastern California, Sonora, Arizona, southwestern Utah, and east to western Texas.

In Lower California, it has been collected, in the Cape Region, at Cabo San Lucas, San Jose del Cabo, La Paz, San Pedro, San Antonio at 803 feet, foothills of the Sierra Laguna at 1,400 feet, Miraflores, Santa Anita, San Ignacio, Santa Rosalia, Ensenada, La Providencia and Cajon canyons in the San Pedro Martir Mountains, Valladares Creek, and the Santo Domingo River.

In California, it has been secured in San Diego (Vallecito), Imperial (Colorado River twenty miles above Picacho), Riverside (Carrizo Creek on the north slope of the Santa Rosa Mountains), San Bernardino (Turtle Mountains near Blythe Junction), and Inyo (Death Valley at Furnace Creek, Cottonwood Canyon at Jackass Spring in the Panamint Mountains), counties.

In Utah it has been found at St. George, Washington County.

In Arizona, it is known to occur in Yuma (Yuma), Coconino (Grand Canyon at Indian Garden, north side of Grand Canyon at Mystic Spring Trail), Maricopa (Cave Creek), Pima (Catalina Mountains 18 miles north from Tucson, Tucson, Roeble's Ranch between Tucson and the Baboquivari Mountains, 5 miles south from Vail), Pinal (five miles east from Phoenix), Santa Cruz (Crittenden), and Cochise (Huachuca Mountains at Ramsey Canyon, one-fourth mile east from Willcox), counties.

It has been taken in Sonora (no definite locality).

Bufo woodhousii Girard

ROCKY MOUNTAIN TOAD

Plate 15, figure 1

Bufo dorsalis HALLOWELL, Proc. Acad. Nat. Sci. Phila., VI., 1852, p. 181 (type locality, "New Mexico" [=San Francisco Mts., Arizona; Stejneger, 1890]); HALLOWELL, Sitgreaves' Exped. Zuni & Colorado Rivers, 1853, p. 142, pl. XIX.

Bufo woodhousii GIRARD, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 86 (Substitute name for *B. dorsalis* Hallowell); BAIRD, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 27; BAIRD, Rep. Pac. R. R. Surv., X, 1859, Rept., pp. 20, 44, pl. XXV, fig. 1; COOPER, Zool., *in* Cronise, Nat. Wealth Calif., 1868, p. 486; COOPER, Proc. Calif. Acad. Sci., IV, 1870, p. 66; COUES, Surv. W. 100th Merid., V, 1875, p. 629; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 142; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 29; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 618, 619; PACK, Copeia, No. 107, 1922, p. 47; PRATT, Verteb. Animals of the U. S., 1923, p. 173; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 27; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 199.

Bufo frontosus COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 301 (type locality, Arizona).

Bufo lentiginosus frontosus COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; YARROW, Surv. W. 100th Merid., V, 1875, p. 520; COUES, Surv. W. 100th Merid., V, 1875, p. 627; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 310; COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 14, 15; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 23, 165; CRAGIN, Trans. Kansas Acad. Sci., VII, reprint 1906, p. 119.

Bufo lentiginosus woodhousei YARROW, Surv. W. 100th Merid., V, 1875, p. 521; COPE, Amer. Naturalist, XXIV, 1890, p. 1204; COCKERELL, Amer. Naturalist, XXX, 1896, p. 326; DICKERSON, Frog Book, 1906, p. 91, color pl. IV, fig. 2, pls. XXV, XXVI; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; TAYLOR, Univ. Calif. Publ. Zool., VII, No. 10, 1912, p. 344; CARY, N. Amer. Fauna, No. 33, 1911, p. 27.

Bufo lentiginosus americanus BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 309, fig. (part); YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 166 (part); COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 284 (part).

Bufo woodhousi BROCCHI, Miss. Sci. Mex., Batrach. Pt. 3, Sec. 2, 1882, p. 74.

Bufo lentiginosus woodhousii COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 281, fig. 69; STEJNEGER, N. Amer. Fauna, No. 3, 1890, p. 116; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 221; RUTHVEN, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 507; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 394; STRECKER, Baylor Bull., XVIII, No. 4, 1915, p. 53; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 101.

Bufo woodhousei ELLIS & HENDERSON, Univ. Colorado Studies, X, No. 2, 1913, pp. 54, 121; ELLIS & HENDERSON, Univ. Colorado Bull., XV, No. 6, 1915, p. 256; ENGLEHARDT, Copeia, 1918, No. 60, p. 78.

Description.—Size large; cranial crests very prominent, forming a right angle back of the orbit and extending laterally to the anterior end of the parotoid gland. Head much broader than body, oval in outline from above; snout truncate, slightly overhanging in profile. Nostrils small, horizontal, nearly terminal; distance between nostrils less than half the interorbital width;

interorbital width twice that of upper eyelid. Tympanum moderate, vertical, broadly oval in outline, surface smooth. Parotoid glands prominent and very elongate, anterior end nearly in contact with orbit; widely separated posteriorly. Limbs robust; inner sole tubercles greatly enlarged, with edge free; one small and one greatly enlarged palm tubercle; small roundish subarticular tubercles present; fingers and toes with small knob-like ends. Skin of dorsal surface rugose, covered with small conical warts, terminating in horny points; under surfaces granular. Tongue narrow, oval in outline, attached centrally and anteriorly.

Ground color above grayish or yellowish, clouded or reticulated with dark brown or black; tips of dorsal warts reddish-brown; limbs barred with black; tips of fingers and toes reddish-brown or black; a narrow grayish dorsal stripe reaching from nostrils to base of the thighs. Under surfaces uniform yellowish, sometimes with a very few scattered black spots on gular region. Throat of male sometimes clouded with black.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	72	73	77	82	98	99
Width of head	27	35	33	36	45	44
Diameter of eye	8	8	7	7	9	9
Interorbital width	5	6	5	7	8	7
Snout to orbit	8	11	8	9	12	12
Fore limb	45	40	43	46	57	54
Hind limb	90	100	92	103	114	111
Length of foot	46	53	53	53	58	54

Habits.—Very abundant at Provo, Utah County, Utah, where it was found in the gardens and under the shade trees along the streets.

Mr. Pack says concerning its food habits: "An examination of the stomach contents of a number of toads disclosed the fact that they were feeding exclusively upon the webworms and that every one was gorged to the limit. These small toads contained from 24 to 40 worms each, the limiting factor in quantity being the size of the stomach. A number of representative toads were weighed, and the stomach contents of each were then removed and weighed. It was found that the contained food represented 16 per cent of the total weight of the toad . . . ."

Distribution.—This toad is said to range from Texas, Kansas, Nebraska, and Montana west to Nevada and southeastern California.

In Utah, it is a common species and has been collected in Cache (Logan), Salt Lake (Fort Douglas, Salt Lake City), Utah (Provo, Fairfield), Wasatch (Little Cottonwood Canyon in the Wasatch Mountains), Emery (Green River), and Washington (Grapevine Spring, St. George, Bellevue, Kolob Plateau at 7,000 to 9,000 feet, Pine Valley Mountains at 7,000 feet), counties.

In Nevada, it has been secured in Lincoln (Pahranagat Valley, Bunkerville, Caliente), and Clark (Vegas Valley, Saint Thomas), counties.

In California, known only from the vicinity of the Colorado River where it has been taken in Imperial County (near Potholes and five miles northeast from Yuma).

In Arizona, it is known from Mohave (Fort Mohave), Coconino (San Francisco Mountains, Tuba, Lee's Ferry), Navajo (Camp Apache, White River Canyon, Winslow), Apache (Fort Defiance, Springerville), Yavapai (Fort Whipple, Beaver Creek near Camp Verde), Maricopa (Phoenix, Chandler, Tempe, Higley, Cave Creek), Yuma (Yuma), Graham (Camp Grant, Ash Creek in the Graham Mountains, Safford), Santa Cruz (Los Nogales, Crittenden), and Cochise (six miles east from Hereford, Willcox, Fairbank), counties.

Bufo cognatus cognatus Say

GREAT PLAINS TOAD

Plate 16, figure 1

Bufo cognatus SAY, Long's Exped. Rocky Mts., II, 1823, p. 190, footnote (type locality, "Arkansas River", Prowers County, Colorado); HOLBROOK, N. Amer. Herpt., ed. 2, V, 1842, p. 21, pl. V; BAIRD & GIRARD, Marcy's Explor. Red River, 1853, p. 242, pl. XI; BAIRD, Rep. Pac. R. R. Surv., X, 1859, p. 44, pl. XXVI; BAIRD, U. S. Mex. Bound. Surv., II, 1859, Rept. p. 26; BROCCHI, Miss. Sci. Mex., Batrach., Pt. 3, Sec. 2, 1882, p. 76; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 275, fig. 67; COPE, Proc. Acad. Nat. Sci. Phila., 1892, p. 332; COPE, Amer. Naturalist, XXX, 1896, p. 1016; DICKERSON, Frog Book, 1906, p. 99, pls. XXX, XXXI, XXXII, XXXIV, fig. 2, color pl. V, fig. 2; RUTHVEN, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 504; STRECKER, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 81; STRECKER, Baylor Univ. Bull., XIII, Nos. 4 & 5, 1910, p. 19; COCKERELL, Univ. Colorado Studies, VII, No. 2, 1910, p. 130; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; ELLIS & HENDERSON, Univ. Colorado Studies, X, No. 2, 1913, pp. 56, 121, pl. I, fig. 1; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 395; ELLIS & HENDERSON, Univ. Colorado Bull., XV, No. 6, 1915, p. 256; Strecker, Baylor Bull., XVIII, No. 4, 1915, p. 52.

Bufo dipternus Cope, Amer. Nat., XIII, 1879, p. 437 (type locality, Montana); Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 308.

Bufo lentiginosus cognatus Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; Yarrow, Surv. W. 100th Merid., V, 1875, p. 521; Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 310; Yarrow, Bull. U. S. Nat. Mus., XXIV, 1883, pp. 23, 165; Cragin, Trans. Kansas Acad. Sci., VII, reprint 1906, p. 119.

Bufo cognatus cognatus Camp, Univ. Calif. Publ. Zool., XII, No. 12, 1915, pp. 331, 333; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 140; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 27; Pack, Copeia, 1922, No. 102, p. 8; Schmidt, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 618, 619; Pratt, Verteb. Animals of the U. S., 1923, p. 173; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 24; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 187.

Description.—Size large; cranial crests prominent, forming an angle back of the orbit, extending laterally between the orbit and the parotoid gland and meeting the upper end of the tympanum. Head broader than long, oval in outline from above; snout vertical in profile. Nostrils small, nearly terminal; distance between nostrils about half the interorbital width; interorbital width equals that of upper eyelid. Tympanum small, roundish in outline. Parotoid glands short, oval in outline. Limbs moderate, inner sole tubercles enlarged, with free edge; outer sole tubercle small; a single large palmar tubercle; small roundish subarticular tubercles present; fingers and toes with small knob-like ends. Skin of dorsal surfaces rugose, thickly covered with small warts; under surfaces granular. Tongue small, elongate, attached centrally and anteriorly.

Ground color above light brown or grayish-brown. Dorsal area marked with wide stripes or large areas of darker gray of various shapes, with thin black borders. A light, rather obscure vertebral stripe is present. Under surfaces uniform yellowish.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	68	71	78	80	82	98
Width of head	27	29	30	30	32	35
Diameter of eye	9	7	10	10	8	11
Interorbital width	6	5	5	5	5	8
Snout to orbit	8	10	10	10	10	13
Fore limb	40	40	41	50	49	52
Hind limb	78	79	81	92	100	105
Length of foot	45	43	45	51	48	54

Habits.—At Coachella, Riverside County, California, these toads were found along the irrigating ditches and under the street lights.

Distribution.—This toad ranges from Wyoming, Kansas, Arkansas, and Texas west to southeastern California.

In California, it has been collected in Imperial (Brawley), Riverside (Mecca, Blythe, Coachella), and San Bernardino (Needles), counties.

In Arizona, it has been found in Mohave (Fort Mohave), Yuma (Yuma), Maricopa (Phoenix), Pima (Tucson, Roeble's Ranch between Tucson and the Baboquivari Mountains), Santa Cruz (Camp Crittenden), and Cochise (Fort Huachuca), counties.

Mr. Pack has reported it from Benson, Cache County, Utah.

It has not been recorded from Nevada, Sonora, or Lower California.

Bufo cognatus californicus Camp

ARROYO TOAD

Plate 16, figure 2

Bufo cognatus californicus CAMP, Univ. Calif. Publ. Zool., XII, No. 12, 1915, p. 331 (type locality, **Santa Paula, 800 feet altitude, Ventura County, California**); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 141; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 28; PRATT, Verteb. Animals of the U. S., 1923, p. 173; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 25; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 192.

Description.—Size small; cranial crests obscure, with narrow separation on midline. Head broader than long, oval in outline from above; snout vertical in profile. Nostrils small, very nearly terminal; distance between nostrils equals interorbital width; interorbital width slightly less than upper eyelid. Tympanum small, oval in outline. Hind limbs very short; inner sole tubercle with free edge; outer sole tubercle terminating in a small horny point; one large and one small palmar tubercle; fingers and toes with small knob-like ends. Skin of dorsal surfaces slightly rugose, covered with small roundish warts; under surfaces granular. Tongue narrow, oval in outline; attached centrally and anteriorly.

Ground color above grayish, with black markings encircling from two to four of the small warts covering the dorsal surfaces. No vertebral stripe. Limbs barred or spotted with black. Under surfaces creamy white, without markings.

MEASUREMENTS OF 5 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	42	44	47	47	55
Width of head	20	20	21	19	22
Diameter of eye	5	4	6	6	7
Interorbital width	3	3	4	3	4
Fore limb	23	26	31	26	32
Hind limb	54	58	67	65	66
Length of foot	27	29	24	23	27

Distribution.—This toad probably is confined to the coastal belt of southern California, where it has been taken at Santa Paula, Ventura County; Tujunga Wash near Sunland, Los Angeles County; and at Campo, Lakeside, Pine Valley, and on the San Luis Rey River, three miles west from Bonsall, San Diego County.

Bufo alvarius Girard

GIANT TOAD

Plate 17

Bufo alvarius GIRARD, U. S. Mex. Bound. Surv., II, 1859, Pt. 2, Rept., p. 26, pl. 41, figs. 1-6 (type locality, **Valley of Gila and Colorado**=Fort Yuma, Calif.); COOPER, Proc. Calif. Acad. Sci., IV, 1870, p. 66; COUES, Surv. W. 100th Merid., V, 1875, p. 628; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 29; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 193; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 265, fig. 62; COPE, Amer. Naturalist, XXX, 1896, p. 1014; DICKERSON, Frog Book, 1906, p. 106, pls. XXXVI, XXXVII, color pl. V, fig. 4; RUTHVEN, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 505; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, pp. 113, 118; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 223; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 395; CAMP, Univ. Calif. Publ. Zool., XII, 1915, p. 509; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, p. 144; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 26; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 618, 619; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 23; PRATT, Verteb. Animals of the U. S., 1923, p. 171; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 163.

Description.—Size very large; head a little broader than long, oval in outline from above. Snout vertical or slightly overhanging in profile. Nostril directed downward, nearer to tip of snout than to orbit; distance between nostrils less than interorbital width; interorbital width about twice that of upper eyelid. Tympanum large, oval in outline; surface smooth. Parotoid glands very elongate and greatly enlarged, separated posteriorly by twice their length. Cranial crests very prominent, forming a curved ridge around the inner edge of the orbit. Limbs robust; a large elongate wart on the femur and two or three smaller roundish ones on the tibia. Dorsal surfaces covered with small roundish tubercles. Feet thick, with large palmar tubercles; subarticular tubercles small and round; fingers with enlarged knob-like ends. Tibia longer than femur; under surfaces of the feet with small tubercles; palm tubercles greatly enlarged; three to four prominent whitish warts at the angle of the jaw. Skin on dorsal surface smooth, becoming rugose laterally. Under surfaces smooth anteriorly, thigh and posterior portion of abdominal region granular.

Dorsal color in alcohol greenish, with reddish tubercles sometimes edged with darker red or brown. Ventral surface yellowish, clouded with gray on gular region. Finger tips reddish-brown or black. Young individuals have the dorsal surfaces covered with small reddish warts or tubercles.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	79	85	110	110	120	130
Width of head	32	35	52	51	52	57
Diameter of eye	7	8	15	11	10	12
Interorbital width	7	9	12	12	15	17
Snout to orbit	11	12	18	18	16	20
Nostril to orbit	6	7	11	10	11	10
Fore limb	41	41	58	60	62	68
Hind limb	90	96	154	148	146	163
Length of foot	44	48	67	65	67	74

Habits.—Abundant at Yuma. Arizona, in the early spring, where it was taken in considerable numbers while feeding on beetles about the electric lights. The stomachs of those taken were found to contain the remains of two or three species of large beetles. At Tucson, Arizona, it was found out on the desert at night a mile or more from the nearest water.

Distribution.—This species has been found in northern Sonora. southern Arizona and southeastern California.

In California, it has been secured only in Imperial County, at Meloland, Holtville, Fort Yuma, and on the Colorado River two miles above Picacho.

In Arizona it has been collected in Yuma (Yuma), Maricopa (Phoenix. Tolladay's Well. Sentinel), Pinal (Maricopa), Pima (Tucson, Sabino Canyon. Catalina Mountains 18 miles north of

Tucson, Pajaritos Mountains, Buenos Ayres, Warsaw Mills), and Graham (Camp Grant), counties.

In Sonora it has been taken in Guadeloupe Canyon, and near Quitovaquito.

Family 7. HYLIDÆ

The members of this family have procœlous vertebræ. The ear is perfectly developed. The skin of the abdominal region is generally areolate. The fingers and toes are with large or small round disks.

Synopsis of Genera

a.—Disks on fingers and toes moderate; head obtuse in front; back without longitudinal lines.........................Hyla.—p. 110

b.—Disks on fingers and toes minute; head long and pointed; longitudinal dorsal lines present.............Pseudacris.—p. 118

Genus 13. Hyla

Hyla Laurenti, Syn. Rept., 1768, p. 32 (type, *viridis*).

In the members of this genus the disks on the fingers and toes are moderately developed. There is a more or less extensive web between the toes. The abdominal region is areolated. Vomerine teeth are present.

Synopsis of Species

a.—Skin rough, with minute tubercles; no dark stripe passing through the orbit...................................H. arenicolor.—p. 110

b.—Skin smooth, a dark band extending along the side of the head and passing through orbit.................H. regilla.—p. 113

Hyla arenicolor Cope

Sonoran Tree-toad

Plate 15, figure 2

Hyla affinis **Baird**, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 61 (type locality, Northern Sonora, Mexico); **Baird**, U. S. Mex. Bound. Surv., II, Rept., 1859, p. 29, pl. XXXVIII, figs. 4-7.

Hyla arenicolor **Cope**, Journ. Acad. Nat. Sci. Phila., Ser. 2, VI, 1866, p. 84 (substitute name for *H. affinis* Baird, not of Spix); **Cope**, Proc. Acad. Nat. Sci. Phila., 1866, p. 301; **Cope**, Bull. U. S. Nat. Mus., No. 1, 1875, p. 31; **Yarrow**, Surv. W. 100th Merid., V, 1875, p. 524; **Coues**, Surv. W. 100th Merid., V, 1875, p. 630;

Yarrow & Henshaw, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., Append. NN, 1878, p. 209; **Cope**, Bull. U. S. Nat. Mus., No. 17, 1880, p. 47; **Boulenger**, Cat. Batrach. Salient. Brit. Mus., 1882, p. 373; **Yarrow**, Bull. U. S. Nat. Mus., No. 24, 1883, p. 175; **Cope**, Bull. U. S. Nat. Mus., No. 32, 1887, p. 14; **Cope**, Bull. U. S. Nat. Mus., No. 34, 1889, p. 396, fig. 93; **Stejneger**, N. Amer. Fauna, No. 3, 1890, p. 117; **Cope**, Amer. Naturalist, XXX, 1896, pp. 1014, 1021, 1022; **Stone**, Proc. Acad. Nat. Sci. Phila., 1903, p. 539; **Dickerson**, Frog Book, 1906, p. 122, pl. XLVIII, color pl. X, fig. 8; **Ruthven**, Bull. Amer. Mus. Nat. Hist., 1907, p. 509; **Strecker**, Proc. Biol. Soc. Wash., XXI, 1908, p. 59; **Stone**, Proc. Acad. Nat. Sci. Phila., 1911, p. 224; **Richardson**, Amer. Naturalist, XLVI, 1912, p. 605; **Van Denburgh & Slevin**, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 392, 394; **Ellis & Henderson**, Univ. Colorado Studies, X, No. 2, 1913, pp. 59, 121; **Van Denburgh & Slevin**, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, p. 100; **Strecker**, Baylor Bull., XVII, No. 4, 1915, p. 50; **Englehardt**, Copeia, 1917, No. 39, pp. 5, 6; **Grinnell & Camp**, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 145; **Stejneger & Barbour**, Check List N. Amer. Amph. Rept., 1917, p. 32; **Englehardt**, Copeia, 1918, No. 60, p. 79; **Stephens**. Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 60; **Schmidt**, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 615, 617, 628, 629, 634; **Pratt**, Verteb. Animals of the U. S., 1923, p. 177; **Stejneger & Barbour**, Check List N. Amer. Amph. Rept., 1923, p. 29; **Storer**, Univ. Calif. Publ. Zool., XXVII, 1925, p. 203.

Hyla copii **Boulenger**, Ann. Mag. Nat. Hist., Ser. 5, XX, 1887, p. 53 (type locality, El Paso, Texas); **Boulenger**, Ann. Mag. Nat. Hist., Ser. 6, I, p. 189.

Description.—Form robust; head broad, depressed; snout rounded in outline from above; canthus rostralis distinct; nostrils nearly terminal, separated by their distance from orbit. Interorbital width nearly twice that of upper eyelid. Tympanum small, distinct, oval in outline, equals about one-half the diameter of orbit. No webs between fingers; present between third and fourth and fourth and fifth toes; two phalanges of fourth toe free. Small inner and outer sole tubercles are present. Tarsal fold prominent; a prominent fold across the breast between the fore limbs. Limbs rather slender; terminal disks of fingers and toes large. Skin rugose, thickly covered with small tubercles. Tongue large, roundish in outline, free laterally and posteriorly.

Color above variable, being light or dark gray, or greenish, mottled with dark gray or blue-gray. Upper surfaces of limbs spotted or barred with dark gray; a dark cross band between the eyes. Under surfaces creamy white, back of thigh tinged with orange or yellow.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to anus	28	29	30	32	33	34
Width of head	11	13	11	12	13	13
Diameter of eye	3	3	3	4	3	4
Interorbital width	3	2	4	4	3	4
Snout to orbit	5	4	5	6	5	5
Fore limb	17	17	14	19	18	18
Hind limb	47	42	45	50	50	46
Length of foot	20	18	19	23	22	20

Habits.—*Hyla arenicolor* is found abundantly in many parts of southern California. In May, 1915, the writer collected numbers of this species in the river bed of the Tujunga River, Los Angeles County. Here they were found congregated in the crevices of the largest granite boulders strewn along the river bed. In some instances as many as 10 or 15 were taken from a single crevice. They were so compact in places that 6 or 7 individuals could be picked up at once. The protective coloration is excellent and a single tree-toad perched on the side of one of these boulders would almost defy detection. In June, 1923, this species was taken at 8,000 feet in the ice cold streams of Arroyo Encantada, San Pedro Martir Mountains, Lower California, Mexico.

Distribution.—This tree-toad ranges from Texas west to the Pacific Ocean, and from southern Utah south in Mexico to Guadalajara and Toluca. It is known from Utah, Arizona, California, and Lower California.

In Utah, it is said to be common about springs, irrigation ditches, and rapidly flowing streams in the region with drainage into the Colorado River. I know of no records of its capture elsewhere than in Washington County, where it has been taken near St. George and near Bellevue.

In Arizona, it is widely distributed and has been collected in Coconino (north side of Grand Canyon on Mystic Spring Trail. south side of Grand Canyon on Bright Angel Trail, Oak Creek), Yavapai (Senator Mountains, Prescott, Fort Verde), Maricopa (Cave Creek), Navajo (White River Canyon), Graham (Graham Mountains at 8,200 feet). Pima (East Sabino Basin, Pima Canyon, Steam Pump 18 miles north from Tucson), Santa Cruz (Santa Rita Mountains at Gardner Canyon and east saddle of "Old Baldy" at 7,500 feet). Cochise (Huachuca Mountains, Ramsey Canyon, Fort Huachuca), counties.

In California, it has been collected in Ventura (three miles south from Nordhoff), Los Angeles (Las Flores, Santa Monica Mountains, Sierra Madre, Tujunga River, La Crescenta, Arroyo Seco Canyon near Pasadena, Little Rock Canyon San Gabriel Mountains, West Fork San Gabriel River, Santa Anita Canyon, Placerita Canyon, San Dimas Canyon, Dominguez Rancho), Riverside (Cabazon, Palm Canyon, and Oak Springs in the San Jacinto Mountains, Dos Palmos Springs, Deep Canyon and Carrizo Creek in the Santa Rosa Mountains, Soboba Springs), and San Diego (Warner Pass, Pine Mountain near Escondido, Julian, Witch Creek, Santa Ysabel, La Puerta, Mountain Springs, Mission Valley, Wildwood, Dulzura, Cottonwood, Barrett Dam, Japatul School), counties.

In Lower California this tree-toad has been secured near Ensenada and in Arroyo Encantada, San Pedro Martir Mountains.

Hyla regilla Baird & Girard

PACIFIC TREE-TOAD

Plate 18

Hyla regilla BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 174 (type locality, "Sacramento River, in Oregon and Puget Sound"); BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., 1853, p. 301; GIRARD, U. S. Explor. Exped., Herpetology, 1858, p. 60, pl. III, figs. 13-18; COOPER & SUCKLEY, Nat. Hist. Washington Terr., 1859, p. 304; BAIRD, Rep. Pac. R. R. Surv., X, 1859, Rept., p. 12, pl. XXVIII, fig. 3; COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 313; COOPER, *in* Cronise, Nat. Wealth of Calif., 1868, p. 485; COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 30; STREETS, Bull. U. S. Nat. Mus., No. 7, 1877, p. 35; YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., [Append. NN, 1878, p. 208; BROCCHI, Bull. Soc. Philom., Ser. 7, I, p. 127; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 374; COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 20, 23, 25; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 171; TOWNSEND, Proc. U. S. Nat. Mus., X, 1887, p. 241; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 355, fig. 89; COPE, Proc. Acad. Nat. Sci. Phila., 1893, pp. 181, 183; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 222; VAN DENBURGH, Bull. U. S. Fish Commiss. for 1894, p. 207; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 556; TEST, Proc. U. S. Nat. Mus.. XXI, 1898, pp. 477, pl. XXXIX; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 3, Zool., IV, No. 1. 1905, pp. 3, 13, 23; DICKERSON, Frog Book, 1906, p. 134, color pls. VIII, IX. pl. LIII; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, pp. 133, 138, 141; TAYLOR, Univ. Calif. Publ. Zool., VII, No. 10, 1912, p. 342; HURTER, First Ann. Rep. Laguna Marine Lab., 1912, p. 67; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, IV, 1914, pp. 135, 137, 144; RUTH-

VEN & GAIGE, Occas. Papers Mus. Zool. Univ. Mich., No. 8, 1915, pp. 11, 14; DICE, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 306, 309; RUTHLING, Lorquinia, I, No. 1, 1916, p. 6; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 144; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 33; BLANCHARD, Copeia, 1921, No. 90, p. 60; STEPHENS, Trans. San Diego Soc. Nat. Hist., Vol. 3, No. 4, 1921, p. 60; NELSON, Mem. Nat. Acad. Sci., XVI, 1921, p. 113; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 615, 617, 620, 621, 629, 633; PRATT, Verteb. Animals of the U. S., 1923, p. 31; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 31; GRINNELL & STORER, Animal Life in the Yosemite, 1924, p. 661; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 215; HARDY, Rep. Prov. Mus. Brit. Columbia, 1925, p. c23; SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, XV, 1926, p. 203.

Hyla scapularis HALLOWELL, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 183 (type locality, Oregon Territory).

Litoria occidentalis BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1853, p. 301 (type locality, San Francisco).

Hyla nebulosa HALLOWELL, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 96 (type locality, Tejon Pass); HALLOWELL, Rep. Pac. R. R. Surv., X, 1859, p. 21.

Hyla scapularis var. *hypochondriaca* HALLOWELL, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 97 (type locality, Tejon Pass); HALLOWELL, Rep. Pac. R. R. Surv., X, 1859, p. 21.

Hyla cadaverina COPE, Journ. Acad. Nat. Sci. Phila., Ser. 2, VI, 1866, p. 84 (substitute name for *H. nebulosa* Hallowell, not of Spix); BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 373; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 176, 193.

Hyla curta COPE, Proc. Acad. Nat. Sci. Phila., 1866, p. 313 (type locality, Cape St. Lucas, Lower California); COPE, Bull. U. S. Nat. Mus., No. 1, 1875, pp. 30, 92; BROCCHI, Miss. Sci. Mex., Batrachiens, 1881, p. 39; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 373; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 171, 193; GARMAN, Bull. Essex Inst., XVI, No. 1, 1884, p. 45; COPE, Bull. U. S. Nat. Mus., No. 32, 1887, p. 15; BELDING, W. Amer. Scientist, III, No. 24, 1887, p. 99; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, pp. 351, 360; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1895, p. 557.

Hyla regilla scapularis COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 356.

Hyla regilla regilla COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 356.

Hyla regilla laticeps COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 359 (type locality, Cape St. Lucas, Lower California).

Hyliola regilla MOQUARD, Nouv. Arch. du Mus. Hist. Nat. Paris, Ser. 4, I, 1899, p. 339.

Description.—Form delicate; head depressed; snout sharply oval in outline from above, overhanging in profile; canthus rostralis very distinct; nostrils nearly terminal, separated by their distance from orbit. Interorbital width one and one-half times that of upper eyelid. Tympanum round in outline, equals about one-half the diameter of the orbit. No webs between fingers; webs present between third and fourth and fourth and fifth toes; fourth toe with two phalanges free; a large inner sole tubercle; outer sole tubercle small. A prominent fold extends across breast between fore limbs. Limbs moderate; terminal disks of fingers and toes large. Skin smooth above, areolated on belly. Tongue large, roundish in outline, free laterally and posteriorly.

In coloration *Hyla regilla* is the most variable of any of our western Salientia. The ground color may be gray, green, dark brown or bronze. A black band, underlined with a light stripe extends from shoulder to back of orbit. Narrowing in front of orbit it continues along the canthus rostralis terminating at nostril. Rim of upper jaw generally a dark brown. Dorsal surfaces may be uniform in color or have elongated blotches of brown or redish-brown. Limbs may be barred or spotted with color of dorsal markings. Under surfaces may be whitish, yellowish-white or orange.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	31	32	36	38	39	40
Width of head	11	11	13	13	12	14
Diameter of eye	3	3	3	4	4	4
Interorbital width	3	3	4	3	3	4
Snout to orbit	5	5	5	6	6	6
Fore limb	18	20	18	22	24	26
Hind limb	48	49	48	61	61	64
Length of foot	21	23	25	26	28	29

Habits.—This tree-toad is probably the most abundant batrachian in California, where it ranges from sea-level to 11,600 feet. It may be found abundantly in marsh-lands, lakes, springs, under the bark of trees and in almost any other place where there is continued moisture. It does not appear to congregate in such large compact masses as does *Hyla arenicolor*, but may be found in large colonies during the breeding season.

Distribution.—This species ranges from British Columbia to Cape San Lucas and from the Pacific Ocean east to Idaho and Utah. In Arizona and the deserts of southeastern California it is replaced by *Hyla arenicolor*. The ranges of these two species overlap in southern California and northern Lower California.

In British Columbia, it occurs on Vancouver Island, as well as on the mainland; it has been taken at Chilowyuck or Chilliwak Lake, Sumas Prairies, Beak Lake, Kaslo, Comox Lake, Union Bay, Taylor Bay, Victoria, Esquimalt, and Gabriola Island.

In Washington, it has been collected in San Juan (San Juan Islands), Clallam (Port Townsend, Lake Crescent, Neah Bay, Lapush), Pacific (Shoalwater Bay), Chehalis (Granville, Aberdeen), Mason (Hoodsport), Snohomish (Marysville, Monroe), King (Seattle), Pierce (Fort Steilacoom, Mount Rainier, Paradise Valley), Lewis (Chehalis, eight miles west from Chehalis, Skookumchuck Creek), Wahkiakum (Cathlamet), Clark (Fort Vancouver), Klickitat (Pullman), and Walla Walla (Fort Walla Walla, Prescott), counties.

In Oregon, it has been taken in Clatsop (Astoria), Multnomah (Portland), Lincoln (Toledo), Lane (Eugene), Coos (Myrtle Point), Douglas (Drain, Roseburg, Fort Umpqua), Curry (Harbor), Josephine (Rogue River at Grants Pass), Wasco (Fort Dalles), Crook (two miles from Barnes, Prineville), Klamath (Fort Klamath, Klamath Falls, Lost River), Lake (Silver Lake, Paisley, Chewaucan Valley, Warner Lake, Goose Lake), Umatilla (Meacham), Union (Grand Ronde River at Island City), Wallowa (Fork of Wallowa River, Wallowa Lake), Harney (Harney, Malheur Cave), and Malheur (Jordan Valley), counties.

In Idaho, it has been secured in Boise (Payette Lake, Lardo), and Ada (Boise) counties.

The only Utah record is Ogden, Weber County.

In Nevada, this tree-toad is known to occur in Elko (Elko), Eureka (Eureka), Humboldt (Virgin Valley, Pine Forest Mountains), Washoe (Little High Rock Canyon), Ormsby (Carson City), Nye (Oasis Valley, Ash Meadows, Pahrump Valley), and Clark (Cottonwood Springs, Vegas Valley, Las Vegas, Corn Creek, Spring between Pahrump and Vegas valleys, Charleston Mountains at Mountain Spring), counties.

In California, this species probably occurs in every county except Imperial. It has been collected in Del Norte (Requa), Sisikyou (Seiad Valley, Yreka, Benton Estate on Butte Creek, Sisson), Modoc (Sugar Hill, Goose Lake Meadows near Davis Creek, Parker Creek and Warren Peak in the Warner Mountains, Fort Bidwell), Shasta (Mt. Lassen at 8,000 feet, McCloud River, Baird, Redding), Trinity (Mill Creek), Tehama (Mill Creek two miles northeast from Tehama), Humboldt (Trinidad, Arcata, Eureka, Alton), Mendocino (three miles west from Covelo, Cahto, Sherwood, Willits, Mendocino City, Ukiah, Gualala), Lake (Howard Springs), Sonoma (Cloverdale, seven miles west from Cazadero, Austin Creek, Freestone, Sonoma, Petaluma), Marin (three miles west from Inverness, San Rafael, Mount Tamalpais, Mill Valley, Larkspur, four miles west from Sausalito, Sausalito), Napa (Calistoga, St. Helena, Luscol, Napa, Napa Junction), Yolo (Grand Island, Knight's Landing), Sutter (Yuba, Butte Slough, West Butte), Yuba (Bullard's Bar), Plumas (Quincy), Nevada (Olympic Park), Placer (Lake Tahoe), El Dorado (Fallen Leaf Lake), Amador (five miles east from Carbondale), Calaveras (Mokelumne Hill), Tuolumne (Groveland), Mariposa (Dudley, Pleasant Valley, Porcupine Flat, Mt. Conness at 11,600 feet, Bull Creek Cove near Kinsley, Merced Big Trees, Yosemite Valley), Merced (Snelling, Gadwell, Los Baños), Madera (Northfork, Raymond), Mono (Walker Lake), Inyo (Panamint Mountains at 4,000 to 6,000 feet near Panamint, Johnson Canyon, Surprise Canyon, Hot Springs in Panamint Valley, Shoshone, Saratoga Springs), Fresno (Fresno, Minkler, Kings River at 7,500 feet, Horse Corral Meadows at 8,000 feet, Hume, one mile south from Dunlap), Tulare (Mount Whitney, Whitney Meadows, Whitney Creek, Round Mountain, Ridge north of Manter Meadow, Cedar Creek, Sequoia National Park, Orosi), Kern (west side Walker Pass, Weldon, Kern River at Isabella, Fay Creek near Weldon, Walker Basin, Kern River 25 miles above Kernville, Castac Lake, San Imigdio Creek, Mountains near Fort Tejon, Tejon Pass, Fort Tejon), Contra Costa (Mount Diablo), Alameda (Berkeley, Oakland, Piedmont, Leona Heights, Haywards), San Francisco (Presidio, Golden Gate Park), San Mateo (San Andreas Lake, San Mateo, Redwood City, Menlo Park), Santa Clara (Stanford University, Palo Alto, San Jose, Saratoga, Los Gatos, Gilroy), Santa Cruz (Boulder Creek, Santa Cruz), San Benito (San Juan, Hollister), Monterey (Monterey, Pacific Grove, Carmel), San Luis Obispo (Santa Margarita, Oceano), Santa Barbara (Santa Barbara, Santa Cruz Island, Santa Rosa Island), Ventura (Matilija), Los Angeles (Sierra Madre, Pasadena, South Pasadena, Glendale, Placerita Canyon, El Nogal, Sunset Beach, Santa Catalina Island), San Bernardino (Santa Ana River, Bluff Lake, Seven Oaks, Converse Flats, Dry Lake, Oro Grande), Riverside (Reche Canyon, Riverside, Banning, Cabazon, Gilman Hot Springs, Schain's Ranch in the San Jacinto Mountains), and San Diego (San Diego, Sweetwater Valley, Santa Ysabel, Witch Creek, Julian, Pine Mountains, Campo, La Puerta, Vallecito, San Felipe Valley, Sentenac Canyon, Lakeside, La Jolla, Glen Lonely, Barrett Dam, Cottonwood, Carrizo Creek), counties.

In Lower California, it is known to occur at the Tecate River, Ensenada, San Rafael Valley, San Quentin, Cañon Cantiles, San Pedro Martir Mountains, La Grulla, Valle de las Palmas, Santa Rosalia, San Ignacio, Comondu, Sierra Giganta at Puerto Escondido, La Paz, Sierra Laguna at San Francisquito and at 5,400 feet near Todos Santos, Miraflores, San Jose del Cabo, Cape San Lucas, and on Cerros Island.

Genus 14. Pseudacris

Pseudacris FITZENGER, Syst. Rept., 1843, p. 31 (type, *nigrita*).

In the members of this genus the disks on fingers and toes are very minute. The skin is smooth. The tympanum is distinct. Vomerine teeth are present in two small patches.

A single species is represented in the area under consideration.

Pseudacris triseriata (Wied)

WESTERN MARSH TOAD

Plate 19, figure 1

Hyla triseriata WIED, Reise in das innere Nord-Amerika, Vol. I, Pt. 4, 1838, p. 249 (type locality, Mt. Vernon, Ohio River, Indiana); WIED, Nova Acta Leop. Carol., XXXII, 1865, p. 118.

Helocœtes triseriatus BAIRD, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 60.

Helocœtes clarkii BAIRD, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 60 (type locality, Galveston and Indianola, Texas); BAIRD, U. S. Mex. Bound. Surv., II, Rept., 1859, p. 28, pl. 37, figs. 4-9.

Hylodes maculatus AGASSIZ, Lake Superior, 1850, p. 378, pl. VI, figs. 1-3 (type locality, north shore of Lake Superior).

Chorophilus triseriatus COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 30; COPE, Rep. U. S. Geol. Surv., Terrs., 1871 (1872), p. 469; COPE, Amer. Naturalist, XIII, 1879, p. 437; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 335; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 342, fig. 87; HAY, Amer. Naturalist, XXIII, 1889, p. 770; CARY, N. Amer. Fauna, No. 33, 1911, pp. 27, 40; STRECKER, Proc. Biol. Soc. Washington, XXI, 1908, pp. 48, 58, 82; STRECKER, Trans. Acad. Sci. St. Louis, XVIII, No. 2, 1909, p. 19; STRECKER, Baylor Univ. Bull., XII, No. 1, 1909, p. 19; STRECKER, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 80; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 224; ELLIS & HENDERSON, Univ. Colorado Studies, X, No. 2, 1913, pp. 57, 121; ELLIS & HENDERSON, Univ. Colorado Bull., XV, No. 6, 1915, p. 257, pl. I, figs. 1-4; STRECKER, Baylor Bull. XVIII, No.

4, 1915, p. 48; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 101.

Chorophilus triseriatus triseriatus Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 30; Yarrow, Surv. W. 100th Merid., V, 1875, p. 523; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 170.

Chorophilus septentrionalis Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 335 (type locality, Great Bear Lake).

Chorophilus nigritus Dickerson, Frog Book, 1906, p. 157 (part).

Chorophilus nigritus triseriatus Dickerson, Frog Book, 1906, p. 160.

Pseudacris triseriata Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 31; Pack, Copeia, 1920, No. 77, p. 7; Pratt, Verteb. Animals of the U. S., 1923, p. 178; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 29.

Description.—Form delicate; head narrow, depressed; snout sharply oval in outline from above, overhanging in profile; nostrils much nearer to tip of snout than to orbit, separated by about the interorbital distance; interorbital distance about one and one-half the width of the upper eyelid. Tympanum distinct, very small, equals about one-half the diameter of the orbit, round in outline. Webs between toes very minute; phalanges of toes free; small inner and outer sole tubercles present; subarticular tubercles small and round. Limbs slender; fingers and toes long and delicate, terminating in very minute pads. Skin of dorsal surface smooth or with very minute tubercles; under surface of thighs and belly strongly granular.

Ground color above is flesh or light slate, with three complete or broken longitudinal bands of bluish-black. A dark band beginning at the tip of the snout passes through the eye, over the fore leg, and terminates at a point midway between the limbs. Under surfaces are yellowish-white.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to anus	15	17	18	20	21	22
Width of head	4	5	6	5	6	6
Diameter of eye	1	2	2	2	2	2
Interorbital width	1½	2	2	2	2	2
Snout to orbit	2	3	3	3	3	3
Fore limb	7	10	10	11	11	12
Hind limb	20	24	27	27	29	32
Length of foot	10	13	13	14	14	15

Habits.—This little tree-frog inhabits meadows and small grassy areas in the vicinity of ponds and irrigation ditches. The writer found them in the vicinity of Salt Lake City, Utah, along the edge of a small pond where they were hiding at the bases of small tufts of grass.

Distribution.—This species ranges from the Alleghany Mountains west to Idaho, Utah, Nevada, and Arizona.

In Idaho, it is recorded by Stone as taken at Nampa, Canyon County and it has been collected at Boise, Ada County.

In Utah, it is known to occur in Cache (Logan), Salt Lake (Salt Lake City, Murray), and Wasatch (Provo Canyon in the Wasatch Mountains), counties.

The only Nevada record of which I know is Dr. Stone's of three specimens taken, by Hebard and Rehn, at Las Vegas, Clark County.

In Arizona, it has been collected near Flagstaff, Coconino County.

Family 8. RANIDÆ

The members of this family have the upper jaw toothed; the sternum is well developed; the vertebræ are procœlus; there are no ribs.

Genus 15. Rana

Rana LINNÆUS, Syst. Nat., ed. 10, I, 1758, p. 210 (type, *temporaria*).

In this genus the frontoparictal fontanelle is absent; vomerine teeth are present; fingers without webs; toes with well-developed webs.

SYNOPSIS OF SPECIES AND SUBSPECIES

a.—Dorsolateral longitudinal ridges present.
  b.—Tympanum smooth.
   bb.—Skin smooth.
    c.—No triangular blotch covering tympanum.
     d.—Webs less developed.
      dd.—Size larger; dorsolateral ridges very distinct with definite, narrow, short, longitudinal folds or ridges. Back with very distinct more or less rounded light-margined spots..............................**R. pipiens.**—p. 121
      dd'.—Size smaller; skin of back between dorsolateral ridges without definite, narrow, longitudinal folds or ridges..**R. onca.**—p. 126

d^2.—Webs very full. Dorsolateral ridges less prominent; dorsal spots very small................R. a. aurora.—p. 127

c^2.—A large triangular blotch covering tympanum..R. cantabrigensis.—p. 132

bb'.—Skin rugose.

cc.—Size larger; dorsolateral surfaces with large light-centered spots; posterior surfaces of thighs and lateral surfaces red..R. a. draytonii.—p. 129

cc'.—Size smaller; dorsal surfaces with smaller light-centered spots; no red on sides..............R. pretiosa.—p. 133

b^2.—Tympanum covered with small tubercles.

ee.—Size smaller; webs small and narrow.

f.—Tympanum more tubercular; a light narrow patch on top of head..............R. b. boylii.—p. 136

f'.—Tympanum less tubercular; no light patch on top of head...........................R. b. sierræ.—p. 139

ee'.—Size larger; web very broad; skin in adults very rugose...................................R. b. muscosa.—p. 140

a'.—Dorsolateral ridges not present..........R. catesbeiana.—p. 142

Rana pipiens Schreber

Leopard Frog

Plate 19, figure 2

Rana aquatica Catesby, Carol., II, 1743, p. 70; Klein, Quadruped., p. 119.

Rana halecina Linnæus, Syst. Nat., I, 1766, p. 356; Daudin, Hist. Nat. Rept., VIII, 1803, pp. 122, 432; Daudin, Hist. Nat. Rainettes, Gren. Crap., 1803, p. 63; Harlan, Silliman's Amer. Journ. Sci., X, 1825, p. 62; Harlan, Journ. Acad. Nat. Sci. Phila., V, 1827, p. 337; Harlan, Med. and Phys. Researchs, 1835, pp. 102, 224; Storer, Mass. Reptil., 1839, p. 237; Holbrook, N. Amer. Herpetology, ed. 1, I, 1836, p. 89, pl. XIII; Duméril & Bibron, Erpétologie Génerale, VIII, 1841, p. 352; Thompson, Nat. Hist. Vermont, 1842, p. 120; De Kay, Zool. New York, III, 1842, p. 62, pl. XX, fig. 49; Holbrook, N. Amer. Herpetology, ed. 2, IV, 1842, p. 91, pl. XXII; Hallowell, Proc. Acad. Nat. Sci. Phila., 1856, p. 141; Günther, Cat. Batrach. Salient. Brit. Mus., 1858, p. 13; Cooper, Rep. Pac. R. R. Surv., XII, Pt. II, 1860, p. 304, pl. XXIX, fig. 1; Hayden, Trans. Amer. Philos. Soc., XII, 1863, p. 177; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 301; Cope, Ann. Rep. U. S. Geol. Surv. Terr., 1871 (1872), p. 469; Allen, Proc. Boston Soc. Nat. Hist., XVII, 1874, p. 70; Coues, Surv. W. 100th Merid., V, 1875, p. 631; Brocchi, Miss. Sci. Mex., Batrach., 1881, p. 10; Bou-

LENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 41; COPE, Proc. Acad. Nat. Sci. Phila., 1883, pp. 10, 16; COPE, Proc. Amer. Philos. Soc., XXIII, 1886, p. 517; DUGES, La Naturaleza, Ser. 2, I, 1888, p. 136; GÜNTHER, Biol. Centrali-Americana, Rept., 1900, p. 198; CRAGIN, Trans. Kansas Acad. Sci., VII, reprint, 1906, p. 118; BOULENGER, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 433.

? *Rana virginia* LAURENTI, Syn. Rept., 1768, p. 31.

Rana pipiens SCHREBER, Naturforscher, XVIII, 1782, p. 185, pl. IV, (type locality, Pennsylvania); GMELIN, Syst. Nat., III, 1788, p. 1052; BONNATERRE, Encyclop. Meth. Erpét., 1789, p. 5, pl. IX, fig. 2; SCHNEIDER, Hist. Amph, fasc. I, 1799, p. 153; SHAW, Gen. Zool., Vol. III, Amphib., 1802, p. 105, pl. XXXII; LECONTE, Proc. Acad. Nat. Sci. Phila., 1855, p. 424; GARMAN, Bull. Essex Inst., XX, 1888, p. 95; GARMAN, Bull. Illinois Lab., III, 1892, p. 322; RHOADS, Proc. Acad. Nat. Sci. Phila., 1895, p. 394; DICKERSON, Frog Book, 1906, p. 171, color pls. XI, XII, figs. 1-2, 5-7, pls. LXIII, LXIV, LXV, LXVI, LXVII, LXVIII, LXIX, fig. 216; LXX, figs. 217, 218; RUTHVEN, Bull. Amer. Mus. Nat. Hist., XXIII, 1907, p. 510; STRECKER, Proc. Biol. Soc. Washington, XXI, 1908, pp. 48, 60, 83, 88; STRECKER, Trans. Acad. Sci. St. Louis, XVII, No. 2, 1909, p. 18; STRECKER, Baylor Univ. Bull., XII, No. 1, 1909, p. 9; STRECKER, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 81; STRECKER, Baylor Univ. Bull. XIII, Nos. 4 & 5, 1910, p. 21; COCKERELL, Univ. Colorado Studies, VII, No. 2, 1910, p. 130; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 224; CARY, N. Amer. Fauna, No. 33, 1911, p. 24; HURTER, Herpet. of Missouri, 1911, p. 114; THOMPSON & THOMPSON, Ann. Rep. Board Geol. Surv. Michigan for 1911, Herpetology of Michigan, 1912, p. 49; ELLIS & HENDERSON, Univ. Colo. Studies, X, No. 2, 1913, pp. 60, 121; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, III, 1913, pp. 393, 395; SURFACE, Zool. Bull. Penn. Dept. Agric., III, Nos. 3 & 4, 1913, p. 123; WRIGHT, Publs. Carnegie Inst., No. 197, 1914, p. 52, pl. XV; STRECKER, Baylor Bull., XVIII, No. 4, 1915, p. 45; RUTHVEN & GAIGE, Occas. Papers Mus. Zool. Univ. Mich., No. 8, 1915, pp. 11, 12; ELLIS & HENDERSON, Univ. Colo. Bull., XV, No. 6, 1915, p. 258; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 102; RICHARDSON, Proc. U. S. Nat. Mus., XLVIII, 1915, p. 433; ELLIS, Copeia, 1917, No. 43, p. 39; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 149; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 38; BRYANT, Calif. Fish & Game, III, 1917, p. 90; ENGLEHARDT, Copeia, 1918, No. 60, p. 79; RUTHVEN, Occas. Papers Mus. Zool. Univ. Mich., No. 66, 1919, p. 2; EVERMANN & CLARK, Phys. & Biol. Surv. Lake Maxinkuckee, 1920, p. 638; KLUGH, Copeia, 1922, No. 103, p. 14; SCHMIDT, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 618, 619; PRATT, Verteb. Animals of the U. S., 1923, p. 180; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 36; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 266; STRECKER, Contrib. Baylor Univ. Mus., 1926, No. 2, p. 1, No. 6, p. 8, No. 8, p. 5.

Rana utricularia HARLAN, Silliman's Amer. Journ. Sci., X, 1825, p. 59 (type locality, Philadelphia, Penn.); HARLAN, Journ. Acad. Nat. Sci. Phila., V, 1826 (1827), p. 337; HARLAN, Med. and Phys. Researches, 1835, pp. 102, 223; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 49; GARMAN, Bull. Illinois Lab., III, 1892, p. 321.

Rana palustris GUERIN, Iconogr. Regn. Anim. Rept., 1844, pl. XXVI, fig. 1.

Rana oxyrhynchus HALLOWELL, Proc. Acad. Nat. Sci. Phila., 1856, p. 142, (type locality, Florida).

Rana berlandieri BAIRD, U. S. Mex. Bound. Surv., II, 1859, Rept., p. 27, pl. 36, figs. 7-10 (type locality, Southern Texas).

Rana virescens KALM, Resa til Norra Amerika, III, 1861, p. 46 (type locality, Mexico, United States and Northward); GARMAN, Bull. Essex Inst., XVI, 1884, p. 41; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 397, fig. 100, pls. L, figs. 1, 2, LI, figs. 1-9; COPE, Proc. Acad. Nat. Sci. Phila., 1893, pp. 182, 184; WERNER, Jahresb. Nat. Ver. Magdeb., 1894, p. 128; ATKINSON, Proc. Indiana Acad. Sci., 1895, p. 258; STONE, Proc. Acad. Nat. Sci. Phila., 1903, p. 539; DITMARS, Amer. Mus. Journ., V, 1905, p. 198, fig. 23.

Rana halecina berlandieri COPE, Bull. U. S. Nat. Mus., No. 1, 1875, p. 32; YARROW, Surv. W. 100th Merid., V, 1875, p. 526; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 180.

Rana areolata areolata YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 178 (part).

Rana halecina halecina YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 179.

Rana virescens virescens COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 401, fig. 100.

Rana virescens brachycephala COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 403, fig. 101 (type locality, Yellowstone River); STEJNEGER, N. Amer. Fauna, No. 3, 1890, p. 118; MEARNS, Bull. U. S. Nat. Mus., No. 56, 1907, pp. 103, 110, 113.

Rana pipiens brachycephala TEST, Bull. U. S. Fish Commiss., XI, 1892, p. 57; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 228; VAN DENBURGH, Bull. U. S. Fish Commiss. for 1894, p. 207; STONE, Proc. Acad. Nat. Sci. Phila., 1911, p. 224; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, III, 1912, p. 158; DICE, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 304, 310; CAMP, Univ. Calif. Publ. Zool., XII, No. 17, 1916, p. 503.

Description.—Head about as broad as long, depressed; snout rounded, projecting beyond mouth; canthus rostralis indistinct; loreal region slightly concave; nostrils about equidistant from eye and tip of snout or a little nearer eye; distance between nostrils greater than interorbital width. Interorbital width less than width of upper eyelid. Tympanum large, distinct, nearly smooth, one-half to once diameter of eye. Fore limbs heavy; no rudiment of pollex: digits rather long, first as long as or a little longer than second, third much the longest, a slight fold sometimes present along sides of fingers, subarticular tubercles small or moderately large, rounded, prominent; a slight or no tarsal fold; inner metatarsal tubercle elongate, fairly prominent; outer metatarsal tubercle absent or indistinct; web full; one to three phalanges of fourth toe free. Skin generally smooth, granular on back of thigh, with more or less numerous warts, tubercles, or longitudinal folds on back and sides of body and dorsal surface of hind limb; a well developed dorsolateral fold; a fold from upper lip to side of neck or shoulder. Vomerine teeth in small rounded groups or short transverse or oblique series between or slightly behind the choanæ.

Color above brown, gray, olive, or green, with large, discrete, dark brown or black spots on head, body and limbs. These spots usually are narrowly bordered with light blue, gray, yellow or green, and irregularly rounded. They may unite to form short longitudinal bands, or the spots or their light borders may be wanting. The dorsolateral fold may be light green or bronze or as dark as the ground color. The posterior surface of the thigh may be more or less clouded, spotted, or marbled with brown or gray. All the lower surfaces are white or yellow, sometimes clouded, marbled, or reticulated with gray or brown.

Measurements of 6 Specimens in the Collection of the
California Academy of Sciences

Snout to vent	57	73	74	77	81	100
Snout to orbit	10	11	11	12	12	16
Width of head	20	24	24	27	28	38
Interorbital width	2	3	3	3	4	5
Vertical diameter of tympanum	4	5	5	6	6	9
Fore limb	29	36	37	44	48	60
Hind limb	71	122	121	135	144	155
Length of tibia	30	40	39	42	43	50
Length of foot	32	38	40	43	47	53

Distribution.—This beautiful frog occurs throughout most of North America east of the Cascade Mountains and Sierra Nevada. It has not yet been found in Lower California, but probably occurs along the Colorado River.

In California, it has been collected in Imperial (two miles east of Dixieland, Yuma), Riverside (Riverside Mountain), El Dorado (Lake Tahoe, Fallen Leaf Lake), and Modoc (Alturas), counties.

In Oregon, it has been recorded from Malheur (Ontario), Umatilla (Umatilla), and Wasco (Fort Dalles) counties, and the John Day River.

Washington localities are Walla Walla (Fort Walla Walla, three miles east of Wallula, Touchet), and Stevens (Clark's Fork of the Lower Kootenai River), counties.

In Idaho, it has been collected in Bonner (Sand Point, Hope), Washington (Weiser, Montgomery's Ferry mouth of Weiser River), Canyon (Caldwell), Ada (Boise), Elmore (Mountain Home), Jerome (Spring Branch just above Shoshone Falls), Bingham (Blackfoot, Fort Hall), Power (American Falls), and Bear Lake (Deep Lakes, Bloomington Canyon), counties.

In Utah, this frog has been secured in Cache (Logan Canyon, Dry Lake, Logan), Salt Lake (Salt Lake City, Fort Douglas, Murray), Utah (Provo, Fairfield, Spanish Fork), Wasatch (Provo Canyon, Wasatch Mountains), Sanpete (Ephraim), Emery (Green River), Beaver (Beaver, Beaver Creek), Piute (Kimberly), Iron (Rush Lake, Iron Springs), Garfield (Panguitch), Washington (St. George, Leeds), and San Juan (San Juan River), counties.

In Nevada, it has been found in Washoe (The Willows, Pyramid Lake), Elko (Elko. Carlin), Lincoln (Caliente, Pahranagat Valley), counties.

In Arizona, it has been collected in Coconino (Oak Creek, San Francisco Mountains, Painted Desert at Tanner's Gulch, Tuba), Apache (Alpine), Yavapai (Prescott), Maricopa (Cave Creek, Fort Verde, Beaver Creek near Camp Verde, Tempe, Phoenix), Yuma (Yuma), Pima (Santa Cruz River at Tucson, mouth of Bear Canyon, Santa Catalina Mountains in Sabino Canyon, and at Pusch's Steam Pump 18 miles north from Tucson, Warsaw Mills). Santa Cruz (Santa Rita Mountains near Stetson's Dam and in Gardner Canyon, Camp Crittenden, Fort Buchanan, Calabasas), Cochise (Fairbank, six miles east from Hereford, Ash Canyon. Huachuca Mountains), counties.

Habits.—In the desert areas which this frog inhabits it is generally found along irrigating ditches and the banks of rivers. In the mountain districts it inhabits the grassy meadows, ponds, lakes and streams. It travels long distances overland and may be found in wet grassy areas a mile or more from the nearest water.

Rana onca Cope

NEVADA FROG

Plate 20, figure 1

Rana onca COPE, *in* Yarrow, Surv. W. 100th Merid., V, 1875, p. 528, pl. 25, figs. 1-3 (type locality, Utah); DICKERSON, Frog Book, 1906, p. 196, pl. LXXXII, fig. 257; VAN DENBURGH & SLEVIN, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, p. 100; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 38; BOULENGER, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 409; BOULENGER, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 428; PRATT, Verteb. Animals of the U. S., 1923, p. 183; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 35.

Rana draytoni onca COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 443.

Rana fisheri STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 227, pl. III, fig. 5 (type locality, Vegas Valley, Nevada); STONE, Proc. Acad. Nat. Sci. Phila., p. 224.

Description.—Head as broad as, or broader than, long, slightly depressed; snout rounded, projecting more or less beyond mouth; canthus rostralis indistinct; loreal region concave; nostril nearer to eye than to tip of snout; distance between nostrils greater than interorbital width. Interorbital width less than width of upper eyelid. Tympanum large, distinct, nearly smooth, one-half to once diameter of eye. Fore limbs heavy, no rudiment of pollex; digits rather long, first as long as, or a little longer than, second, third much the longest; no slight fold along sides of fingers; subarticular tubercles small or moderately large, rounded, single. No tarsal fold; inner metatarsal tubercle elongate, fairly prominent; no outer metatarsal tubercle; digits moderately long; web moderately full, one or two phalanges of fourth toe free. Skin above smooth, or with a few tubercles or ridges on back and sides of body and dorsal surface of hind limbs; a strong dorso-lateral fold; a fold or series of warts from upper lip to side of neck or shoulder. Vomerine teeth in small, rounded groups or short oblique series between or a little behind the choanæ.

Color above is brown, gray, olive, or green, with large or small discrete, dark brown spots on head, body and limbs. These spots usually are indefinitely bordered with light blue, gray, yellow, or green, and are irregularly rounded. They may form longitudinal rows, or the spots or their light borders may be nearly absent. The dorso-lateral fold may be light or as dark as the general ground color. Posterior surface of thigh may be more or less clouded, spotted or marbled with brown or gray. Lower surfaces white or yellow, sometimes clouded, marbled or reticulated with gray or brown, especially on the throat.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	45	48	51	56	57	60
Snout to orbit	7	9	9	8	9	10
Width of head	17	18	20	21	22	23
Interorbital width	2	2	2	3	3	3
Vertical diameter of tympanum	3	4	4	5	5	5
Fore limb	25	27	28	30	31	34
Hind limb	67	76	80	80	85	95
Length of tibia	21	23	24	25	25	28
Length of foot	22	24	26	27	26	30

Distribution.—This frog is known only from Utah and Nevada. The only Utah record is of Dr. Yarrow's single female specimen, without more definite locality, collected in 1872.

In Nevada, this frog has been found only in Clark County, where it is common near Las Vegas. The Death Valley Expedition secured it at Las Vegas Ranch, Vegas Valley.

Habits.—Our specimens were all caught in a small stream from a flowing well about a mile northwest of the town of Las Vegas.

Rana aurora aurora Baird & Girard

WESTERN WOOD-FROG

Plate 20, figure 2

Rana aurora BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 174 (type locality, Puget Sound); GIRARD, U. S. Explor. Exped., Herpetology, 1858, p. 18, pl. II. figs. 1-6; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 225; VAN DENBURGH, Bull. U. S. Fish Commiss. for 1894, p. 207; DICKINSON, Frog Book 1906, p. 216, pl. LXXXII, figs. 258, 259, color pl. XIV; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 4, III, 1912, p. 159; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 36; BOULENGER, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 410; BOULENGER, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 448; PRATT, Verteb. Animals of the U. S., 1923, p. 183.

Rana temporaria aurora YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 185 (part).

Rana agilis aurora COPE, Proc. Amer. Philos. Soc., XXIII, 1886, p. 521; COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 439, fig. 113, (part); COPE, Proc. Acad. Nat. Sci., Phila., 1893, pp. 181, 183; MEEK, Field Columb. Mus., Zool. Ser. I, 1899, p. 332.

Rana aurora aurora Camp, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 123, 124; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 148; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 34; Hardy, Rep. Prov. Mus. Brit. Columbia, 1925, p. c23; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 229.

Description.—Head broader than long, depressed; snout rounded, projecting a little beyond mouth; canthus rostralis fairly prominent; loreal region slightly oblique; nostril equidistant or nearer to tip of snout than to orbit; distance between nostrils equals interorbital width. Interorbital width equals width of upper eyelid. Tympanum small, distinct, smooth, about one-half diameter of eye. Limbs long and slender, digits long, first a little longer than second, third longest; no lateral fold on sides of fingers; subarticular tubercles small, rounded, moderately prominent; inner metatarsal tubercle elongate, fairly prominent; outer metatarsal tubercle absent or obscure; web full; two phalanges of fourth toe free. Skin smooth, back of thighs granular; dorso-lateral fold more or less obscure; a fold from the upper lip to the side of the neck or shoulder. The vomerine teeth are in two oblique patches between and behind the choanæ.

Color above light brown, sometimes tinged with red, with small black spots on the head, body, and limbs. Posterior surface of thigh more or less clouded, speckled, or mottled with gray; canthus rostralis edged with black. Lower surfaces are yellowish, clouded or reticulated with dark gray.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	42	43	44	51	56	70
Snout to orbit	7	7	7	8	10	11
Width of head	17	14	15	18	21	26
Interorbital width	3	3	3	3	4	5
Vertical diameter of tympanum	3	3	3	3	4	4
Fore limb	28	27	28	27	36	42
Hind limb	79	80	82	90	108	130
Length of tibia	23	24	24	27	33	40
Length of foot	24	25	27	29	36	39

Distribution.—This frog is confined to a narrow strip of territory along the Pacific Coast from British Columbia to Oregon and possibly to extreme northwestern California.

In British Columbia, it has been taken on Vaucouver Island, and at Vancouver, Hatzic, and Selkirk Settlement.

In Washington, it has been collected in Clallam (Lake Crescent, Neah Bay), Jefferson (Hoh River near Fischer's Ranch near Spruce), Pierce (Tacoma), Chehalis (Quinault, Aberdeen), Pacific (South Bend, Trapp Creek, Melbourne, Shoalwater Bay, Ilwaco), Snohomish (Darrington), King (Seattle), Lewis (Skooumchuck River near Chehalis), and Skamania (Carson, Skamania), counties.

In Oregon, it has been collected in Clatsop (Astoria, Seaside), Multnomah (Portland), Clackamas (Clear Creek near Oregon City), Lane (Eugene, Mapleton), Douglas (Fort Umpqua, Takenitch Lake), Jackson (Prospect), and Klamath (Crater Lake), counties.

Californian specimens from Del Norte (Crescent City) and Humboldt (Eureka) counties have been identified as *Rana a. aurora.*

Habits.—*Rana a. aurora* is essentially a wood-frog. Oregon and Washington specimens were taken among the ferns and dense vegetation, in the forests of the coastal belt.

Rana aurora draytonii Baird & Girard

CALIFORNIA RED-LEGGED FROG

Plate 21, figure 1

Rana draytonii BAIRD & GIRARD, Proc. Acad. Nat. Sci., Phila., VI, 1852, p. 174 (type locality, San Francisco, California); GIRARD, U. S. Explor. Exped., Herpetology, 1858, p. 23, pl. II, figs. 19-24; COOPER, *in* Cronise, Nat. Wealth of Calif., 1868, p. 485; COPE, Proc. Amer. Philos. Soc., XXIII, 1886, p. 521; STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 225; VAN DENBURGH, Proc. Calif. Acad. Sci., Ser. 2, V, 1896, p. 1008; DICKERSON, Frog Book, 1906, p. 213, pls. LXXX, LXXXI, color pl. XV; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 37; BOULENGER, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 410; BOULENGER, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 446; NELSON, Mem. Nat. Acad. Sci., XVI, 1921, p. 113.

Rana lecontii BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1853, p. 301 (type locality, San Francisco); GÜNTHER, Cat. Batrach. Salient., 1858, p. 15; COOPER, Proc. Calif. Acad. Sci., IV, 1870, p. 64; BROCCHI, Bull. Soc. Philom., I, p. 179; BROCCHI, Miss. Sci. Mex., Batrach., 1881, p. 14, pl. IV, fig. 1; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 43.

Rana nigricans HALLOWELL, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 96 (type locality, El Paso Creek, Kern County, California); BOULENGER, Bull. Soc. Zool. France, 1880, p. 207; BROCCHI, Miss. Sci. Mex., Batrach., 1881, p. 15, pl. IV, fig. 3 (part); BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 43.

Rana longipes HALLOWELL, Rep. Pac. R. R. Surv., X, 1859, Williamsons' Rept., pt. IV, No. 1, p. 20, pl. X, fig. 1 (type locality,

El Paso Creek, Kern County, California); Cooper, Proc. Calif. Acad. Sci., IV, 1870, p. 64.

Rana draytoni Cooper, Proc. Calif. Acad. Sci., IV, 1870, p. 64; Pratt, Verteb. Animals of the U. S., 1923, p. 183.

Rana temporaria aurora Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 32; Yarrow & Henshaw, Ann. Rep. Chief of Engineers for 1878, Append. NN, 1878, p. 209; Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 28; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 185 (part).

Epirhexis longipes Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 176 (part).

Rana septentrionalis Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 182 (part).

? *Rana catesbiana* Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 184 (part).

Rana temporaria pretiosa Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 432 (part).

Rana agilis aurora Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 439 (part).

Rana draytoni draytoni Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 441, fig. 114 (part).

Rana aurora Chamberlain, Rept. U. S. Fish Commiss. 1897 (1898) p. 225 (part).

Rana aurora draytonii Camp, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 123, 124; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 148; Schmidt, Bull. Amer. Mus. Nat. Hist., XLVI, Art. XI, 1922, pp. 612, 615, 634; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 34; Grinnell & Storer, Animal Life in the Yosemite, 1924, p. 666; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 231.

Rana aurora draytoni Stephens, Trans. San Diego Soc. Nat. Hist., III, No. 4, 1921, p. 60.

Description.—Head broader than long, not greatly depressed; snout rounded, projected beyond mouth; canthus rostralis moderate or indistinct; loreal region slightly concave; nostrils about equidistant from eye and tip of snout; distance between nostrils greater than interorbital width. Interorbital width less than width of upper eyelid. Tympanum small, distinct, smooth, about one-half diameter of eye. Fore limbs robust; digits long, first a little longer than second, third much the longest; fingers without lateral fold; subarticular tubercles large, rounded, prominent; inner metatarsal tubercle small, elongate; outer metatarsal tubercle absent; web full; two phalanges of fourth toe free. Skin in large males very rugose, granular on back of thigh, with more or less numerous warts or tubercles on back and sides of body; a well developed dorso-lateral fold; a prominent fold from edge of upper lip to shoulder; sacral hump very prominent. Vomerine teeth in two rounded groups between the choanæ.

Color above light or dark brown, with large or small irregular black spots on dorsal surface of back and thighs. These spots are sometimes greatly elongated, with light centers. Sides, anterior portions of femur and the under surfaces, are yellowish or whitish, spotted or reticulated with black. Lower sides of body and under surfaces of hind limbs are a rich salmon-red. Specimens from the San Pedro Martir Mountains, Lower California are much darker and show none of the red so characteristic of those from northern California. Sides and anterior portions of thigh of Lower California specimens are yellowish, strongly reticulated with black.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	59	66	70	73	74	77
Snout to orbit	9	10	10	11	12	12
Width of head	24	23	28	27	28	29
Interorbital width	3	4	3	4	3	4
Vertical diameter of tympanum	4	4	6	5	5	5
Fore limb	36	39	42	44	48	44
Hind limb	113	122	128	133	135	130
Length of tibia	35	36	42	44	42	43
Length of foot	38	37	39	44	42	38

Distribution.—This large frog ranges from Del Norte County, California to northern Lower California.

In California, it has been collected in Del Norte (Requa), Siskiyou (Lower Klamath Lake), Humboldt (Arcata, Eureka), Trinity (Gumboot Lake), Shasta (Redding), Mendocino (three miles west from summit of Mount Sanhedrin, Mendocino City, Gualala), Sonoma (mouth of Russian River, Petaluma), Napa (Calistoga, Luscol, Napa), Marin (four miles west from Inverness, San Rafael, Sausalito), Alameda (Berkeley, Oakland, Temescal, Thornhill Station), San Francisco (Presidio, Golden Gate Park), San Mateo (South San Francisco, Woodside), Santa Clara (Isabel Creek near Mount Hamilton, Stanford University, Los Gatos), Santa Cruz (Boulder Creek, Santa Cruz), Monterey (Monterey, Pacific Grove, Carmel), San Luis Obispo (Shandon, Pozo, Edna, Oceano), Placer (Michigan Bluff), El Dorado, Merced (Snelling, Gadwell), Fresno (Minkler), Kern (El Paso Creek, mountains near Fort Tejon), Santa Barbara (Santa Barbara), Los Angeles (Mint Canyon four miles from Saugus, Placerita Canyon, Santa Anita Wash, Sierra Madre, Rustic Canyon in the Santa Monica Mountains, El Nogal), San Bernardino (Victorville, Oro Grande, Colton), Riverside (Riverside), and San Diego (Witch Creek, San Diego, Campo, San Felipe Valley, Sentenac Canyon, Boulder Creek, Lakeside), counties. In Lower California, it has been secured in the San Pedro Martir Mountains, and at La Grulla, San Tomas, and Rancho San Antonio.

Habits.—This frog is probably the best known in California, and as food is considered to be more desirable and more delicate than the introduced Bullfrog. It usually inhabits still water, and is found in ponds, lakes, and marshes, although it is occasionally found in running streams. The specimens from Lower California in the Academy's collection, were taken in small ponds at an elevation of 8,000 feet, in the San Pedro Martir Mountains.

Rana cantabrigensis Baird

NORTHERN WOOD-FROG

Rana cantabrigensis BAIRD, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 62 (type locality, Cambridge, Mass.); BOULENGER, Bull. Soc. Zool. France, 1880, p. 209; BOULENGER, Cat. Batrach. Salient. Brit. Mus., 1882, p. 45; DICKERSON, Frog Book, 1906, p. 211; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 35; PRATT, Verteb. Animais of the U. S., 1923, p. 182.

Rana cantabrigensis cantabrigensis COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 436, fig. 110.

Rana cantabrigensis latiremis COPE, Proc. Amer. Philos. Soc., XXIII, 1886, p. 520 (type locality, Lake Alloknagik, Alaska); COPE, Bull. U. S. Nat. Mus., No. 34, 1889, p. 435, fig. 111; DICKERSON, Frog Book, 1906, p. 212; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 37; DICE, Occas. Papers Mus. Zool. Univ. Mich., No. 85, 1920, pp. 7, 11; PATCH, Copeia, 1922, No. 111, p. 77; HARDY, Rep. Prov. Mus. Brit. Columbia, 1925, p. c24.

Description.—Head about as broad as long, depressed, snout oval, projecting beyond mouth; nostril about equidistant from eye and tip of snout; distance between nostrils greater than interorbital width. Interorbital width about equal to width of upper eyelid. Tympanum small, distinct, oval in outline. Limbs slender; digits moderately long, first and second about equal, third much the longest; hind limbs moderately long; heel reaching to about middle of orbit. Inner metatarsal tubercle elongate, prominent; outer metatarsal tubercle absent; web very full; two phalanges of fourth toe free. Skin smooth; a well developed dorsolateral fold. The vomerine teeth are in two small rounded groups between the choanæ.

The color in alcohol is brownish, with two wide dorsolateral stripes of gray, the area between these stripes being spotted with reddish oval markings, bordered with black. Some individuals have a narrow dorsal stripe reaching from the tip of the snout to the vent. The sides are grayish, spotted with black, the dorsolateral stripe sometimes having a black border, extending through the orbit and along the canthus rostralis to the tip of the snout. A large triangular patch of black back of the orbit covers the tympanum. The limbs are barred or spotted with black. A grayish stripe borders the upper jaw. The under surfaces are grayish or yellowish, the abdominal region sometimes spotted with black.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA

Snout to vent	36	38	40	41	48	49
Snout to orbit	7	7	6	7	8	7
Width of head	16	15	15	16	20	20
Interorbital width	2	2	3	3	3	3
Vertical diameter of tympanum	2	2	2	3	3	3
Fore limb	23	22	22	26	23	26
Hind limb	58	60	65	70	75	70
Length of tibia	18	21	21	22	25	26
Length of foot	10	19	20	25	28	25

Distribution.—This frog ranges from Michigan westward to Minnesota, northward through Canada to British Columbia, Great Slave Lake and Alaska.

In Alaska it has been taken at Yakutat and Lake Alloknagik.

British Columbia records are Hazelton, Atlin, Meadow Lake, twenty miles north of Clinton, and the Kispiox Valley, twenty-three miles north of Hazelton.

Rana pretiosa Baird & Girard

WESTERN SPOTTED FROG

Plate 21, figure 2

Rana pretiosa BAIRD & GIRARD, Proc. Acad. Nat. Sci. Phila., VI, 1853, p. 378 (type locality, Puget Sound); BAIRD, Proc. Acad. Nat. Sci. Phila., 1854, p. 62; BAIRD, Proc. Acad. Nat. Sci. Phila., 1855, p. 378; GIRARD, U. S. Explor. Exped., Herpetology, 1858, p. 20, pl. II, figs. 13-18; COOPER, Rep. Pac. R. R. Surv., XII, Pt. II, 1860, p. 304; COPE, U. S. Geol. Surv. Terr., 1871 (1872),

p. 469; Cope, Amer. Naturalist, 1879, p. 435; Boulenger, Bull. Soc. Zool. France, 1880, p. 208; Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 43; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 186 (part); Cope, Proc. Acad. Nat. Sci. Phila., 1883, pp. 16, 20; Stejneger, N. Amer. Fauna, No. 5, 1891, p. 112; Test, Bull. U. S. Fish Commiss., XI, 1892, p. 58; Van Denburgh, Bull. U. S. Fish Commiss. for 1894, p. 207; Chamberlain, Rept. U. S. Fish Commiss., 1897 (1898), p. 255; Dickerson, Frog Book, 1906, p. 218, color pl. XVI, pl. LXXXIII; Van Denburgh, Proc. Calif. Acad. Sci., Ser. 4, III, 1912, p. 159; Van Denburgh & Slevin, Proc. Calif. Acad. Sci., Ser. 4, V, No. 4, 1915, pp. 100, 102; Dice, Univ. Calif. Publ. Zool., XVI, No. 17, 1916, pp. 314, 321; Boulenger, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 432; Boulenger, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 452; Pratt, Verteb. Animals of the U. S., 1923, p. 184.

Rana septentrionalis Yarrow, Surv. W. 100th Merid., V, 1875, p. 528; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 182 (part).

Rana temporaria pretiosa Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 432, fig. 110 (part); Cope, Proc. Acad. Nat. Sci. Phila., 1893, pp. 182, 184; Meek, Field Columbian Mus., Zool, Ser., I, No. 12, 1899, p. 232.

Rana pretiosa luteiventris Thompson, Proc. Biol. Soc. Wash., XXVI, 1913, p. 53, pl. 3, figs. 2, 3 (type locality, Annie Creek, Elko County, Nevada); Ruthven & Gaige, Occas. Papers Mus. Zool. Univ. Mich., No. 8, 1915, p. 13; Camp, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 123, 124; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 148; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 39; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 36.

Rana pretiosa pretiosa Camp, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 123, 124; Grinnell & Camp, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 148; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 38; Blanchard, Copeia, 1921, No. 90, p. 6; Patch, Copeia, 1922, No. 111, p. 78; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 36; Hardy, Rep. Prov. Mus. Brit. Columbia, 1925, p. c23; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 270.

Description.—Head broader than long, depressed; snout rounded, projecting more or less beyond mouth; canthus rostralis indistinct; loreal region very oblique, concave; nostril equidistant from tip of snout and orbit; distance between nostrils equal to or less than interorbital width. Interorbital width greater than width of upper eyelid. Tympanum moderate or small, distinct, smooth, about one-half diameter of eye. Fore limbs moderately heavy; digits rather long; no rudiment of pollex; first digit as long as or a little longer than second, third much the longest; no slight fold along sides of fingers; subarticular tubercles large, rounded, single. Inner metatarsal tubercle elongate, fairly prominent; no outer metatarsal tubercle; web full; terminal phalange of fourth toe free. Skin above, on sides of body and dorsal surface of limbs rough; a prominent dorso-lateral fold. Vomerine teeth in short oblique series between or a little behind the choanæ.

Color above light or dark brown, with irregular large or small black spots on back and sides, more prominent between the dorso-lateral ridges. In some individuals these black spots are obscure or almost lacking. Upper surfaces of limbs cross-barred with black. Posterior surface of thigh may be clouded or mottled with dark gray. Under surfaces yellowish or salmon, clouded or marbled with gray.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	59	60	62	64	65	67
Snout to orbit	8	8	10	10	11	11
Width of head	19	20	21	24	25	27
Interorbital width	4	4	5	5	6	5
Vertical diameter of tympanum	3	3	3	3	3	4
Fore limb	33	34	38	34	41	40
Hind limb	90	92	108	100	110	113
Length of tibia	30	27	33	34	34	38
Length of foot	32	29	36	35	36	35

Distribution.—This frog ranges from Alaska south to northern California, and east to Utah and Montana.

In Alaska it has been taken on Sergief Island.

In Canada, it has been taken at Banff, Alberta, and in British Columbia, at Watson Lake, Meadow Lake, Clinton, on the Stikine River at Sawmill Lake, Flood Glacier and Doch-da-on-Creek, at Kootenay Lake, Moose Lake, North Fork Moose River, Lake Bennett, Penticton, Okanagan, Hanceville, Hazelton, Sicamous, and Field.

In Washington, it has been found in Clallam (Lake Crescent), Mason (Lake Cushman), King (Seattle), Pierce (Mount Rainier), Skasmania (Mount Adams), Chelan (Entiat, Entiat River at 1,820 feet twenty miles from mouth of river), Yakima (North Yakima, Yakima Indian Reservation, Bumping Lake), Klickitat (Trout Lake), Stevens (Springdale), Spokane (Little Spokane River at Dart's Mill, Clark Spring, Spokane), Whitman (Palouse River at Colfax, Pullman), Walla Walla (Walla Walla), and Columbia (Blue Mountains, Butte Creek, Humpeg Falls, Starbuck), counties.

In Oregon, it has been secured in Clatsop (Gearhart), Tillamook

(Garibaldi), Multnomah (Portland), Coos (Myrtle Point), Crook (Crooked River, Prineville, ten miles west of Prineville), Klamath (Crater Lake, Old Fort Klamath, Sprague River, Klamath Falls, Klamath Lake), Lake (Warner Lakes), Umatilla (Umatilla River near Pendleton, Meacham), Union (Island City, Grande Ronde River), Wallowa (Fork of Wallowa River), Malheur (Jordan Valley), counties, and in the Deschutes River.

In California, it has been collected in Siskiyou (Butte Creek, Sisson), Shasta (Lake Helen, Manzanita Lake, Lassen Peak, Fall City Mills, Fall River, Deer Flat), Modoc (Pine Creek near Alturas, South Fork of Pit River near Alturas), Plumas (Hot Spring Valley, Willow Lake), Tehama (Mineral, Black Butte, Boomer Lake, Battle Creek Meadows), counties.

In Nevada, it has been reported from Lake Tahoe and from Maggie Basin and Annie Creek near Carlin.

In Idaho, it occurs in Bonner (Sand Point, Hope), Kootenai (Coeur d'Alene, Mount Carlton), Adams (Indian Valley), Valley (Payette Lake, McCall, Lardo), Lemhi (Lemhi Mountains at 5,400 feet), Custer (Sawtooth, Pettit Lake), Blaine (Guyer Hot Springs near Ketchum), counties, and in the Salmon River Mountains at 8,000 feet.

In Utah, it has been found in Salt Lake (Fort Douglas, Salt Lake City, Murray), Utah (Provo), and Wasatch (Provo Canyon, Wasatch Mountains), counties.

Habits.—*Rana pretiosa* is found abundantly in the high mountain streams and small ponds left by the melting snow. It is strictly an aquatic frog and is seldom found any distance from water.

Rana boylii boylii Baird

CALIFORNIA YELLOW-LEGGED FROG

Plate 22, figure 1

Rana boylii Baird, Proc. Acad. Nat. Sci. Phila., VII, 1854 (1855), p. 62 (type locality, California, interior, [probably El Dorado County]); Baird, Rep. Pac. R. R. Surv., X, Pt. IV, 1859, p. 12; Cooper, *in* Cronise Nat. Wealth Calif., 1868, p. 485; Cooper, Proc. Calif. Acad. Sci., IV, 1870, p. 64; Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 444, fig. 115 (part); Boulenger, Ann. & Mag. Nat. Hist., Ser. 6, VIII, 1891, p. 453; Stejneger, N. Amer. Fauna, No. 7, 1893, p. 226; Dickerson, Frog Book, 1906, p. 221, pl. LXXXIV, figs. 1, 2, 3, color pl. II, fig. 7; Van Denburgh, Proc. Calif. Acad. Sci., Ser. 4, 3, 1912, p. 159; Boulenger, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 411 (part); BOULENGER, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 469 (part); GRINNELL & STORER, Animal Life in the Yosemite, 1924, p. 663.

Rana pretiosa YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., App. NN, 1878, p. 210 (part); YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 186 (part).

Rana pachyderma COPE, Proc. Acad. Nat. Sci. Phila., 1883, p. 25 (type localities, McCloud River [at Baird, Shasta County,] California, and Ashland, Oregon); TOWNSEND, Proc. U. S. Nat. Mus., X, 1887, p. 241.

Rana boylii boylii CAMP, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 117, 123; GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 146; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 36; STORER, Copeia, 1923, No. 114, p. 8; PRATT, Verteb. Animals of the U. S., 1923, p. 183; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 34; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 245.

Description.—Size small; head broader than long, depressed; snout rounded, projecting beyond mouth; canthus rostralis distinct; loreal region concave; nostrils nearer to tip of snout than to orbit; distance between nostrils equals interorbital width. Interorbital width less than width of upper eyelid. Tympanum small, distinct, covered with small tubercles, about one-half diameter of eye. Fore limbs moderately robust; digits rather long, first and second equal, third much the longest; no lateral fold along sides of fingers; subarticular tubercles small or moderately large, rounded, prominent; outer metatarsal tubercles elongate, prominent, inner metatarsal tubercle rounded, somewhat obscure; web full, extending to tip of longest toe. Skin rugose, covered with warts or tubercles on back and sides; posterior surface of the thigh covered with small tubercles; dorso-lateral fold obscure; sacral hump rather prominent; a well developed fold from lip to side of neck or shoulder. Vomerine teeth in two oblique series, widely separated anteriorly, between and a little behind the choanæ.

Color above grayish or brownish, clouded or with indistinct black markings on body and limbs. A light patch sometimes forming a band extends transversely between the eyes. Sides grayish, mottled with black. Under surfaces yellowish or whitish, gular region mottled or reticulated with black. Under surface of the thigh yellowish.

Measurements of 6 Specimens in the Collection of the California Academy of Sciences

Snout to vent	30	37	44	51	53	55
Snout to orbit	5	6	7	6	8	8
Width of head	10	13	17	20	19	20
Interorbital width	3	3	3	3	3	4
Vertical diameter of tympanum	2	2	4	4	3	3
Fore limb	18	18	27	30	33	35
Hind limb	51	62	86	88	93	100
Length of tibia	17	21	26	30	28	33
Length of foot	15	16	27	27	27	30

Distribution.—This frog has been found only in Oregon and California.

In Oregon, it seems to be confined to the southwestern part of the state, where it has been taken in Douglas (Camas Mountains, Drain, Umpqua River, Deer Creek near Roseburg), Jackson (Ashland), and Curry (Harbor), counties.

In California, it occupies the northern half of the state, excepting the high Sierra Nevada where it is replaced by *R. b. sierræ*. It has been collected in Humboldt (Elinor, Carlotta, Alton, Cuddeback), Trinity (eight miles east of South Yolla Bolly Mountains), Shasta (Sweet Briar Camp, Baird), Tehama (Mill Creek, near Tehama), Plumas (Quincy), Mendocino (three miles south from Covelo, Cahto, Laytonville, Sherwood, six miles north from Willits, Willits, three miles south from summit of Mount Sanhedrin, Usal Creek, Ukiah, Gualala), Glenn (Winslow, Fruto), Butte (Chamber's Ravine near Oroville), Yuba (Bullards Bar), Sonoma (North Fork of Gualala River, Skaggs Springs, eight miles west from Cazadero, Camp Meeker, Freestone), Solana (Vacaville), Yolo (four miles west from Winters), Contra Costa (near Mount Diablo), Napa (Calistoga, Luscol, Napa Junction), Marin (Camp Taylor, Tocoloma, Lagunitas, Muir Woods, Mount Tamalpais, Mill Valley, Fairfax, Paper Mill Creek, San Anselmo, Phoenix Gulch), El Dorado (Fyffe at 3,600 feet), San Joaquin (Corral Hollow, near Tracy), Merced (Sweeney's Ranch, near Los Baños), Mariposa (three miles northeast from Coulterville, Coulterville, Pleasant Valley at 6,000 feet, Sweetwater Creek two miles southeast of Feliciana Mountain at 3,800 feet), Fresno (Kings River, Dunlap, Hume), Kern (Fay Creek at 4,100 feet, six miles north from Weldon, Kern River near Bodfish, Kernville), Mono (Mono Lake at Farrington's), Alameda (Berkeley, Oakland), San Mateo (San Andreas Lake), Santa Clara (Palo Alto, Stanford University, Berryessa, San Jose, Steven's Creek, Los Gatos, Coyote Creek), Santa Cruz (Boulder Creek), San Benito (The Pinnacles), Monterey (Abbot's Ranch, Arroyo Seco), and San Luis Obispo (Santa Margarita), counties.

Habits.—This little frog inhabits the slow-flowing streams of the coastal areas, and may be found in considerable numbers in the semi-permanent pools, formed as the streams become low at the end of the rainy season.

Rana boylii sierræ Camp

SIERRA NEVADA YELLOW-LEGGED FROG

Plate 22, figure 2

Rana pretiosa YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., Append. NN, 1878, p. 210; YARROW, Bull. U. S. Nat. Mus., No. 24, 1883, p. 186; STEJNEGER, N. Amer. Fauna No. 7, 1893, p. 226.

Rana aurora STEJNEGER, N. Amer. Fauna, No. 7, 1893, p. 225 (part).

Rana boylii sierræ CAMP, Univ. Calif. Publ. Zool., XVII, 1917, p. 120 (type locality, Matlack Lake, 10,500 feet altitude, two miles southwest of Kearsarge Pass, Sierra Nevada, Inyo County, California); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 146; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917, p. 36; PRATT, Verteb. Animals of the U. S., 1923, p. 183; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 34; GRINNELL & STORER, Animal Life in the Yosemite, 1924, p. 663; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 263.

Rana boylii BOULENGER, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 469.

Description.—Same as for *Rana b. boylii*, from which it differs in structural characteristics, having a shorter hind leg and the tympanum less tubercular.

Color above dark brown, with numerous black and yellowish-brown spots on head, body and limbs. Lips yellowish mottled with brown. Posterior surface of thigh yellowish, gular region clouded or mottled with black. The white head markings characteristic of *R. b. boylii* are absent.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	38	42	46	58	61	72
Snout to orbit	6	7	7	7	10	9
Width of head	13	15	18	20	23	26
Interorbital width	2	3	3	4	3	5
Vertical diameter of tympanum	2	2	2	3	4	5
Fore limb	23	26	30	32	40	40
Hind limb	61	72	82	92	115	122
Length of tibia	20	22	27	29	37	40
Length of foot	20	22	26	26	35	38

Distribution.—This subspecies, as restricted by Camp, occupies the higher regions of the southern half of the Sierra Nevada, where it has been collected in El Dorado (Fallen Leaf Lake), Tuolumne (Young Lake at 10,000 feet, Tuolumne Meadows at 8,600 feet, Evelyn Lake, head of Lyell Canyon, at 9,700 to 10,500 feet, Vogelsang Pass at 10,450 feet), Mariposa (Sunrise Trail crossing of Sunrise Creek at 7,300 feet, Vogelsang Lake, Porcupine Flat at 8,100 feet, Lake Tenaya, Mono Meadows, one mile north of Peregoy Meadow), Madera (Chiquito at 9,800 feet), Inyo (Matlack Lake at 10,500 feet near Kearsarge Pass), and Tulare (Taylor Meadow at 7,000 feet near Kern County line, Jackass Meadows at 7,500 feet, Monache Meadow, Ranshaw Meadow at 8.800 feet, Whitney Meadows at 9,800 feet, East Fork Kaweah River at 10,200 feet, Mineral King at 7.500 feet, Whitney Creek at 11,500 feet, Halstead Meadows at 7,000 feet in Sequoia National Park, South Fork Kern River at Tunnel, Soda Springs, Volcano Creek, Crabtree Meadows, Manter Meadow at 7,000 feet), counties.

Habits.—Found in the small lakes and ponds scattered about the high mountain meadows.

Rana boylii muscosa Camp

SOUTHERN YELLOW-LEGGED FROG

Rana pretiosa YARROW & HENSHAW, Ann. Rep. Chief of Engineers for 1878, Surv. W. 100th Merid., App. NN, 1878, p. 210 (part); YARROW, Bull. U. S. Nat. Mus. No. 24, 1883, p. 186 (part).

Rana boylii muscosa CAMP, Univ. Calif. Publ. Zool., XVII, No. 9, 1917, pp. 118, 123 (type locality, Arroyo Seco Canyon, at about 1,300 feet altitude near Pasadena, California); GRINNELL & CAMP, Univ. Calif. Publ. Zool., XVII, No. 10, 1917, p. 147; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1917,

p. 36; PRATT, Verteb. Animals of the U. S., 1923, p. 183; STEJNEGER & BARBOUR, Check List N. Amer. Amph. Rept., 1923, p. 34; STORER, Univ. Calif. Publ. Zool., XXVII, 1925, p. 262.

Description.—Same as for *R. b. boylii,* from which it differs in structural characteristics, in attaining a larger size and in having a broader expanse of web.

In coloration there is a marked difference. Ground color above light gray or yellowish, with numerous black blotches or reticulation on head, body and limbs. Posterior surface of thigh rich yellow. Under surfaces yellowish or whitish, gular region slightly spotted or marbled with gray.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	51	55	56	60	62	63
Snout to orbit	9	10	8	9	9	10
Width of head	20	23	22	25	24	30
Interorbital width	5	5	5	4	5	5
Vertical diameter of tympanum	3	3	3	3	3	3
Fore limb	35	35	36	39	35	45
Hind limb	96	103	105	119	107	125
Length of tibia	30	33	34	35	35	40
Length of foot	28	29	30	33	31	37

Distribution.—This subspecies is known only from southern California, where it has been collected in Ventura (Nordhoff), Los Angeles (Arroyo Seco Canyon near Pasadena, Sierra Madre, Santa Anita Canyon, Little Rock Canyon, West Fork San Gabriel River at 3,000 feet, Little Santa Anita Canyon, Eaton's Canyon in the San Gabriel Mountains, Mount Wilson, La Crescenta), San Bernardino (Barton Creek at 6,000 feet, Fish Creek at 6,500 feet, and Santa Ana River in the San Bernardino Mountains), and Riverside (Snow Creek near Whitewater at 2,500 feet, Cabazon at 2,000 feet, Hemet Lake, Palm Springs, Fuller's Mill at 5,600 feet, Schain's Ranch at 4,900 feet, Strawberry Valley at 6,000 feet, and Keen Camp in the San Jacinto Mountains), counties.

Habits.—Found more commonly in the boulder strewn streams of the southern California mountain ranges.

Rana catesbeiana Shaw

Bullfrog

Plate 23

Rana maxima americana aquatica Catesby, Carol., II, 1743, p. 72, pl.

Rana boans Lacepede, Hist. Quad. Ov., I, 1798?

Rana catesbeiana Shaw, Gen. Zool., III, Pt. I, 1802, p. 106, pl. XXXIII, (type locality, North America); Le Conte, Proc. Acad. Nat. Sci. Phila., 1855, p. 423; Cope, Bull. U. S. Nat. Mus., No. 1, 1875, p. 32; Boulenger, Cat. Batrach. Salient. Brit. Mus., 1882, p. 36; Hinckley, Proc. Boston Soc. Nat. Hist., XXI, 1882, p. 311, pl. V, figs. 1, 2, 7; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, p. 184 (part); Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 424, fig. 108, pls. L, fig. 3, LI, figs. 4-8, LV, fig. 6, LXVI, LXVII (part); Garman, Bull. Illinois Lab., III, 1892, p. 328; Rhoads, Proc. Acad. Nat. Sci. Phila., 1895, p. 300; Stejneger, Proc. U. S. Nat. Mus., XXIV, 1901, p. 212; Ditmars, Amer. Mus. Journ., V, 1905, p. 203, fig. 1; Cragin, Trans. Kansas Acad. Sci., VII, reprint 1906, p. 118; Dickerson, Frog Book, 1906, p. 227, pls. LXXXVI, LXXXVII, LXXXIX, XC, fig. 278, XCI, XCII, XCIII, XCIV, XCV, XCVI; Strecker, Proc. Biol. Soc. Wash., XXI, 1908, pp. 48, 61, 83, 88; Strecker, Baylor Univ. Bull., XII, No. 1, 1909, p. 9, Strecker, Trans. Acad. Sci. St. Louis, XVIII, No. 2, 1909, p. 18; Strecker, Trans. Acad. Sci. St. Louis, XIX, No. 5, 1910, p. 81; Hurter, Trans. Acad. Sci. St. Louis, XX, 1911, p. 61; Thompson & Thompson, Ann. Rep. Board Geol. Surv. Mich. for 1911, Herpetology Michigan, 1912, p. 59; Wright, Publ. Carnegie Instit., No. 197, 1914, p. 77, pl. XIX; Ellis & Henderson, Univ. Colorado Bull., XV, No. 6, 1915, p. 258; Strecker, Baylor Bull., XVIII, No. 4, 1915, p. 46; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1917, p. 37; Boulenger, Ann. & Mag. Nat. Hist., Ser. 9, III, 1919, p. 408; Wright, Bull. U. S. Bureau Fish. 1920, p. 5; Boulenger, Proc. Amer. Acad. Arts & Sci., LV, No. 9, 1920, p. 418; Evermann & Clark, Phys. & Biol. Surv. Lake Maxinkuckee, 1920, p. 643; Storer, Calif. Fish & Game, VIII, No. 4, 1922, p. 219; Pratt, Verteb. Animals of the U. S., 1923, p. 181; Stejneger & Barbour, Check List N. Amer. Amph. Rept., 1923, p. 35; Storer, Univ. Calif. Publ. Zool., XXVII, 1925, p. 276; Strecker, Contrib. Baylor Univ. Mus., 1926, No. 2, p. 2, No. 4, No. 6, p. 8, No. 7, p. 5.

Rana mugiens Merrem, Tentamen Systems Amph., 1820, p. 175; Gravenhorst, Rep. Mus. Zool. Vratislaviensis, I, Chelonia et Batrachia, 1829, p. 40; Dumeril & Bibron, Erpétologie Générale, VIII, 1841, p. 370; Wagler, Naturliches System der Amphibien, 1830, p. 203; Tschudi, Classification der Batrachier, 1838, p. 79; Günther, Cat. Batrach. Salient. Brit. Mus., 1858, p. 36; Wied, N. Acta Acad. Leop. Carol., XXII, 1865, p. 106.

Rana scapularis Harlan, Silliman's Amer. Journ. Sci., X, 1825, p. 59 (type locality, Pennsylvania); Harlan, Journ. Acad. Nat.

Sci. Phila., V, 1827, p. 338; HARLAN, Med. & Phys. Researches, 1835, pp. 103, 221.

Rana pipiens HARLAN, Silliman's Amer. Journ. Sci., X, 1825, p. 62; HARLAN, Journ. Acad. Nat. Sci. Phila., V, 1827, p. 335; HARLAN, Med. & Phys. Researches, 1835, pp. 101, 225; HOLBROOK, N. Amer. Herpetology, ed. 1, III, 1838, p. 81, pl. XV; STORER, Mass. Rept., 1839, p. 235; THOMPSON, Nat. Hist. Vermont, 1841, p. 119; DE KAY, Zool. New York, III, 1842, p. 60, pl. XIX, fig. 48; HOLBROOK, N. Amer. Herpetology, ed. 2, IV, 1842, p. 77, pl. XVIII; BAIRD & GIRARD, Marcy's Exped. Red River, 1853, p. 243.

Rana conspersa LE CONTE, Proc. Acad. Nat. Sci. Phila., 1855, p. 425 (type locality, Pennsylvania).

Rana catesbyana SMITH, Geol. Surv. Ohio, IV, 1882, p. 712.

Description.—Head as broad as, or a little broader than long, depressed; snout rounded, projecting far beyond mouth; canthus rostralis indistinct; loreal region very oblique, slightly concave; nostril about equidistant from eye and tip of snout, or a little nearer to eye; distance between nostrils a little greater than interorbital width. Interorbital width less than, or equal to, width of upper eyelid. Tympanum large, distinct, nearly smooth, nearly as large as eye in females, larger in males. Fore limbs robust; digits rather long, first as long as, or a little longer than, second, third much the longest; a slight fold often present along sides of fingers; subarticular tubercles small or moderately large, rounded, fairly prominent, single; no tarsal fold; inner metatarsal tubercle elongate, indistinct or fairly prominent; no outer metatarsal tubercle; web full, one phalange of fourth toe free. Skin smooth, or with few or numerous granulations, small warts, or ridges on back and sides of body and posterior surface of hind limb; no dorsolateral fold. A strong fold present from above and behind tympanum to side of neck or shoulder. Vomerine teeth in small groups or short oblique series between or slightly behind the choanæ.

Color above yellowish, grayish, greenish, or brownish-olive, unmarked or more or less clouded, marbled, spotted, or dotted with darker gray, brown or black. Dorsal surface of limbs may or may not be cross-barred with darker coloring. Posterior surface of thigh usually marbled with gray or brown. Ventral surfaces white or yellow, often marbled on chin, throat and limbs with gray or brown.

MEASUREMENTS OF 6 SPECIMENS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Snout to vent	78	90	106	108	108	114
Snout to orbit	12	14	17	16	17	17
Width of head	28	33	40	36	38	41
Interorbital width	5	5	6	5	7	6
Vertical diameter of tympanum	6	8	8	8	9	9
Fore limb	46	54	61	59	64	64
Hind limb	115	144	166	165	171	183
Length of tibia	40	46	58	57	57	58
Length of foot	44	50	60	59	58	63

Distribution.—The common bullfrog of the eastern United States has been introduced into California and Idaho, and is common near Boise, Ada County. In California, specimens have been recorded from Sonoma Creek, El Verano, and Agua Caliente, Sonoma County, and from Mockingbird Lake near Riverside.

Habits.—The Academy's specimens from Idaho were taken in small pools along the banks of the Boise River.

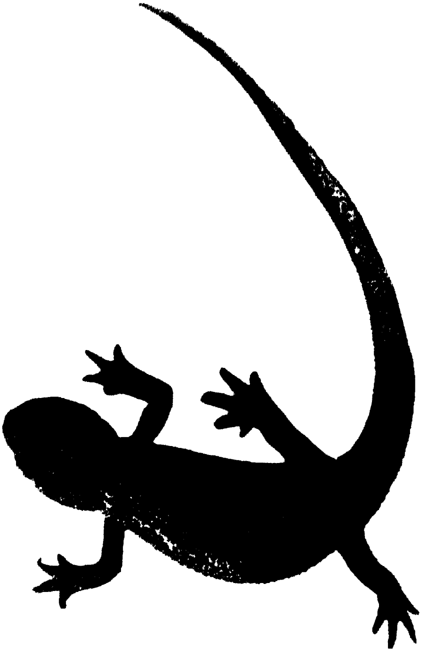
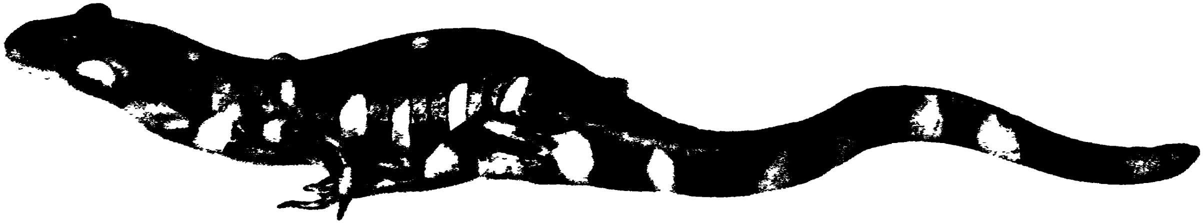
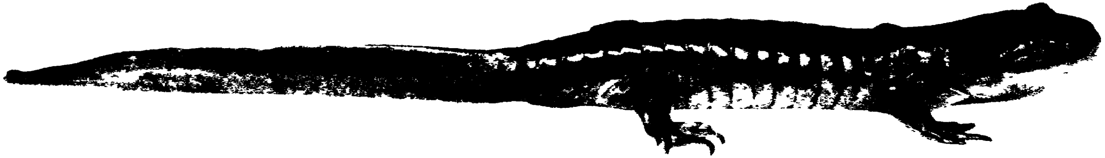


Fig. 1. *Triturus torosus*, Pacific Coast Newt
Collected at Los Gatos, Santa Clara County, California, September, 1921
Natural size.

Fig. 2. *Ambystoma macrodactylum*, Long-toed Salamander
Collected at Crater Lake, Klamath County, Oregon, June, 1918.
Natural size.

September 15, 1928

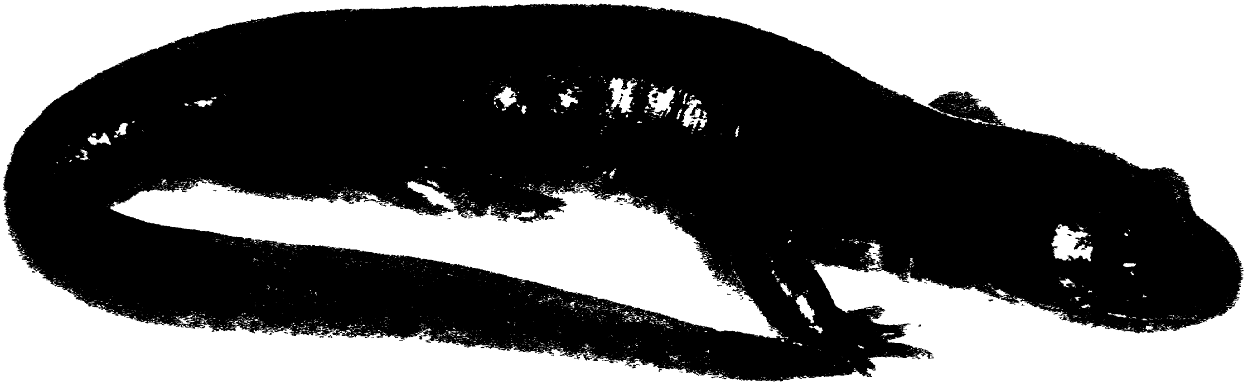




Ambystoma tigrinum, Tiger Salamander

Fig 1 Adult Collected at San Juan, San Benito County, California March 1918
Natural size.

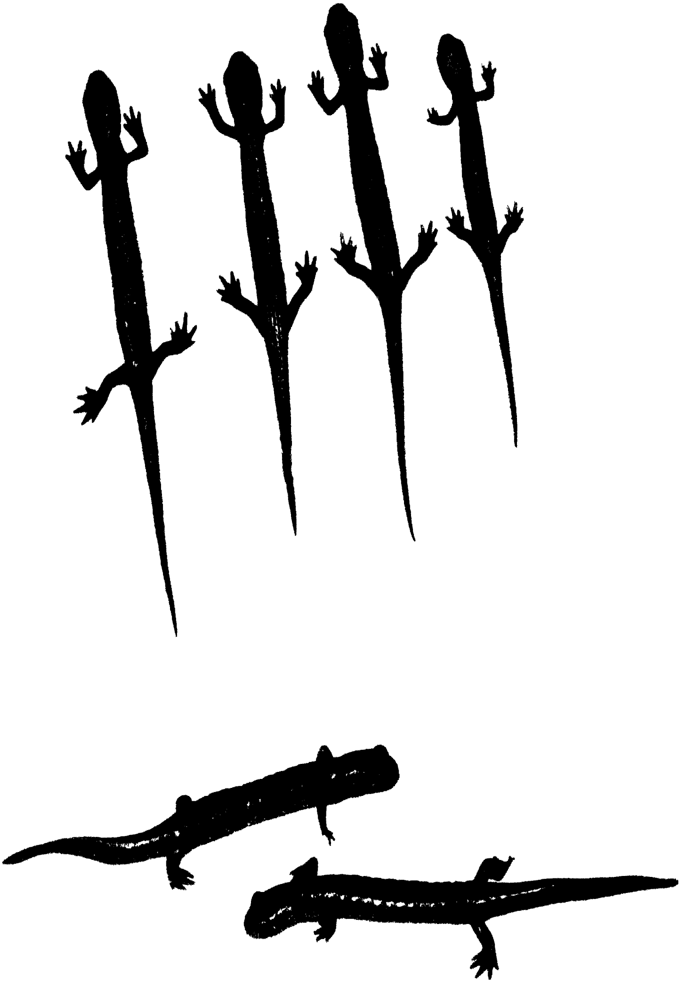
Fig 2 Young with gills Collected at Lake Solitude, Wasatch County, Utah.
July 1913 Natural size



Dicamptodon ensatus, Pacific Giant Salamander

Collected at La Honda, San Mateo County, California, October, 1916

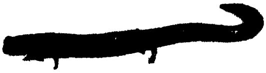
Natural size

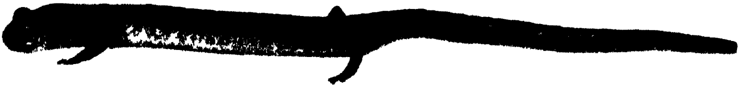


Rhyacotriton olympicus, Olympic Salamander

Collected at Fischer's, Hoh River Jefferson County Washington September 1919

About natural size





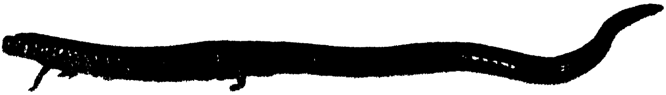
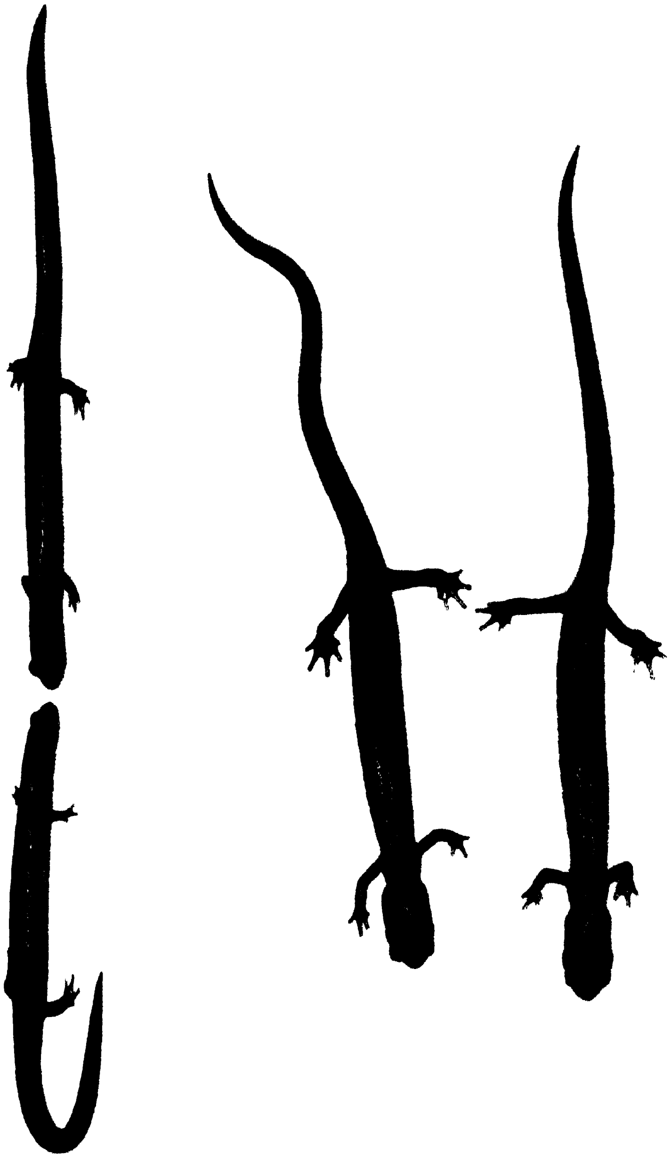


Fig. 1. *Batrachoseps attenuatus leucopus*, Coronados Islands Salamander
Collected at Poway, San Diego County, California, March, 19[illegible]
About one-half natural size

Fig. 2. *Batrachoseps attenuatus pacificus*, Island Salamander
Collected at San Miguel Island, California, April 1913. Natural size

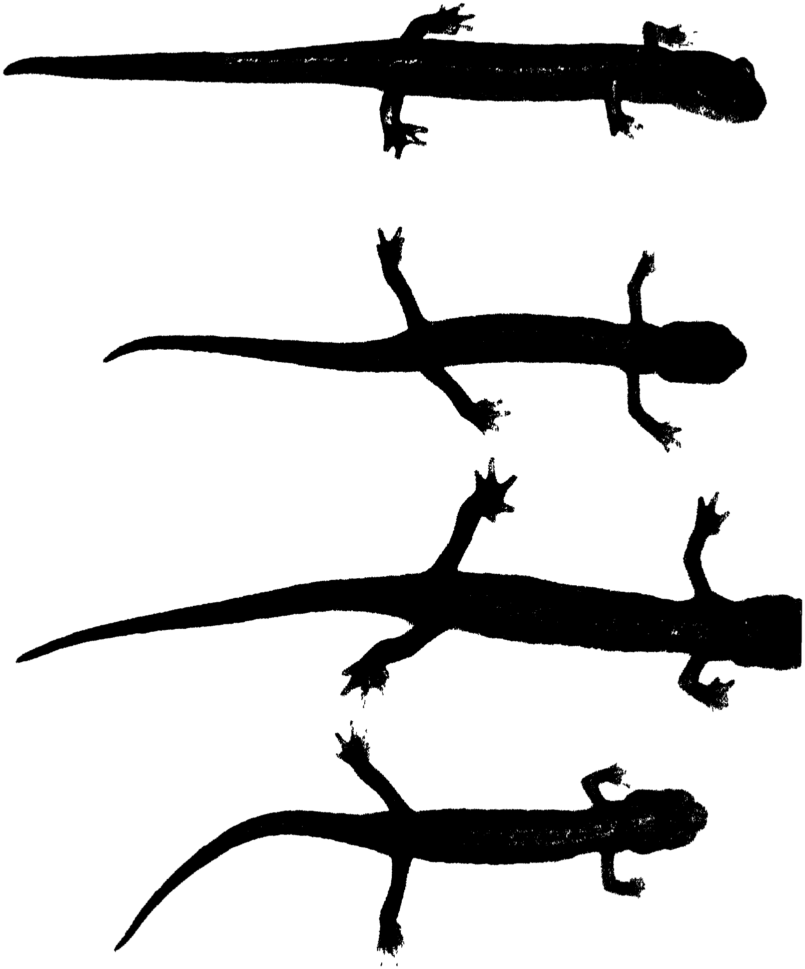
Fig. 3. *Batrachoseps attenuatus attenuatus*, Slender Salamander
Collected at Carmel, Monterey County, California, April 1927. Natural size



Plethodon intermedius, Western Red-backed Salamander

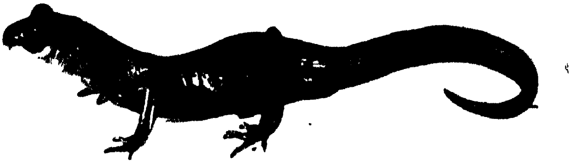
Collected near Spruce, Hoh River, Jefferson County, Washington, September, 1919

Natural size



Plethodon vandykei, Washington Salamander

Collected near Forks, Clallam County, Washington, September, 1919. Natural size.



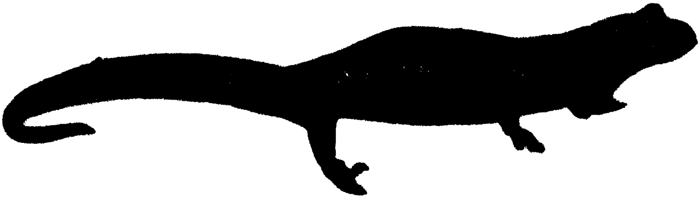
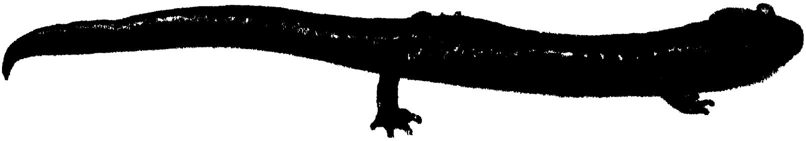


Fig. 1. *Ensatina eschscholtzii*, *Red Salamander*
Collected at Carmel, Monterey County, California, April, 1927. Natural size.

Fig. 2. *Ensatina croceater*, Sierra Salamander
Collected at Oakzanita, San Diego County, California, February, 1927. Natural size.



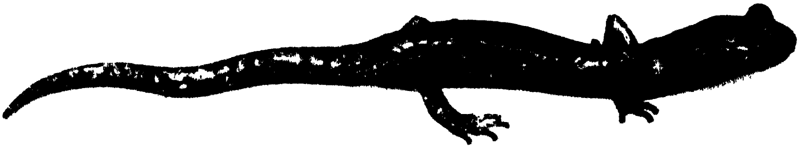
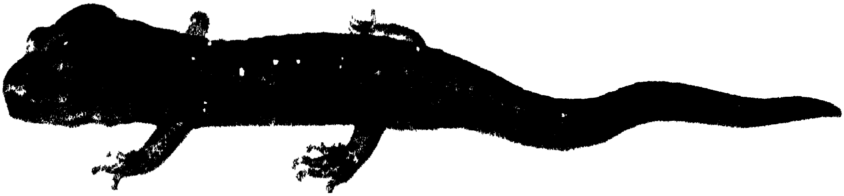
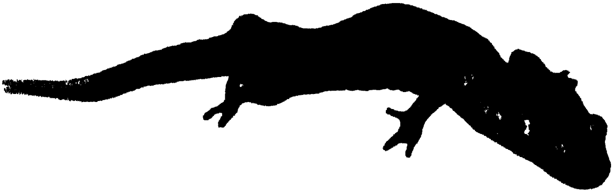


Fig. 1. *Aneides flavipunctatus*, Black Salamander
Collected at Los Gatos, Santa Clara County, California, November, 1912.
Natural size.

Fig. 2. *Aneides ferreus*, Clouded Salamander
Collected at Comptche, Mendocino County, California, July, 1918. Natural size.





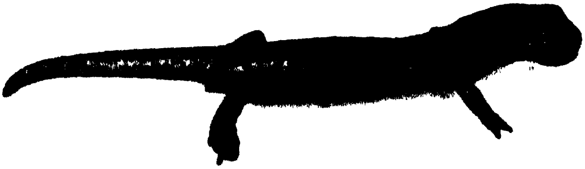
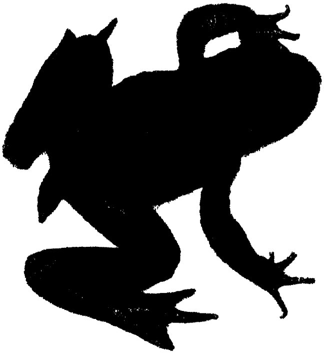


Fig. 1. *Aneides lugubris lugubris*, California Yellow-dotted Salamander
Collected at Los Gatos, Santa Clara County, California, November, 1912. Natural size.

Fig. 2. *Aneides lugubris farallonensis*, Farallon Yellow-dotted Salamander
Collected on South Farallon Island, California, Oct. [illegible] 192[illegible]. Natural [illegible]

Fig. 3. *Hydromantes platycephala*, Mount Lyell Salamander
Collected near Lyell Glacier, Tuolumne County, California, September, 192[illegible].
Natural size.



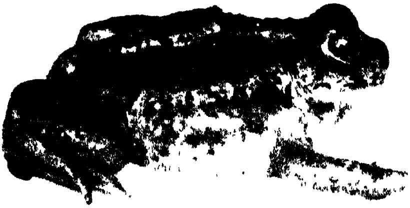
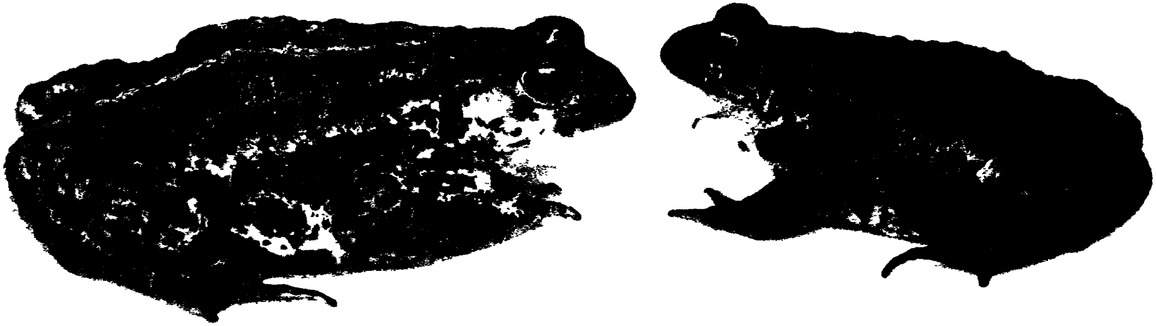
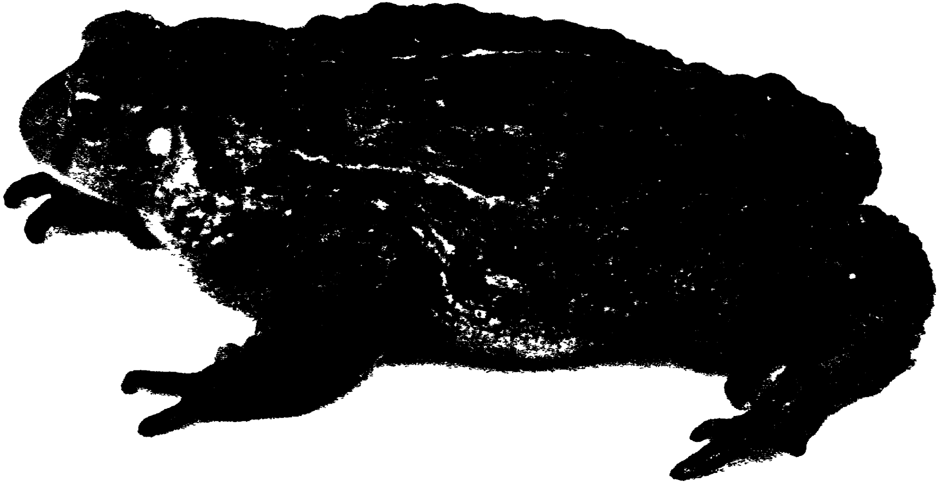


Fig. 1. *Ascaphus truei*, American Ribbed Toad
Collected in Mount Rainier National Park, Pierce County, Washington
July, 1911. Natural size.

Fig. 2. *Scaphiopus hammondii*, Western Spadefoot
Collected at Pyramid Lake, Washo County, Nevada, July, 1916.
Natural size.

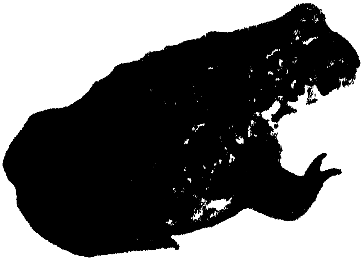


Bufo boreas boreas, Northwestern Toad
Collected at Fischer's, Hoh River, Jefferson County, Washington, September, 1919
About natural size



Bufo boreas halophilus, California Toad

Collected at San Francisco, California, November, 1912. Natural size.



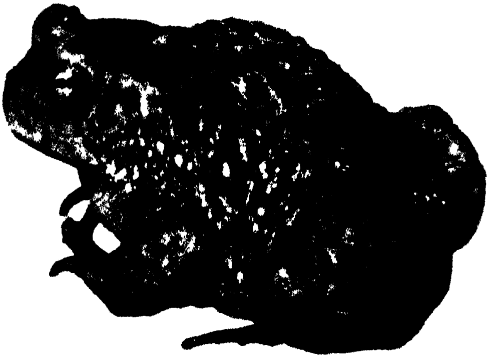
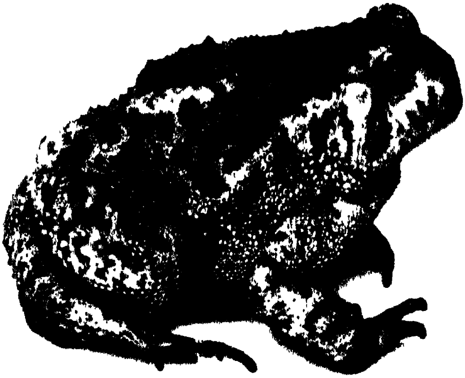


Fig. 1. *Bufo canorus*, Yosemite Park Toad
Collected in Yosemite National Park, Tuolumne County, California,
September, 1922. About natural size.

Fig. 2. *Bufo compactilis*, Sonoran Toad
Collected at Caliente, Lincoln County, Nevada, August, 1917. Natural size.



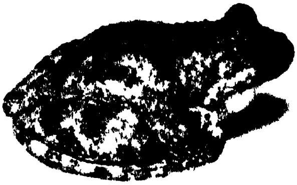


Fig. 1. *Bufo woodhousii*, Rocky Mountain Toad
Collected at Fairbank, Cochise County, Arizona, August, 1912.
About two-thirds natural size.

Fig. 2. *Hyla arenicolor*, Sonoran Tree-toad
Collected near Los Angeles, Los Angeles County, California, May, 1915. Natural size.

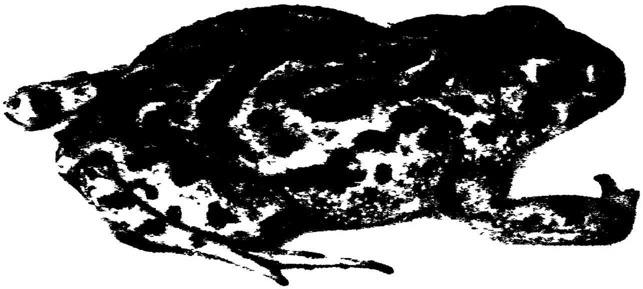
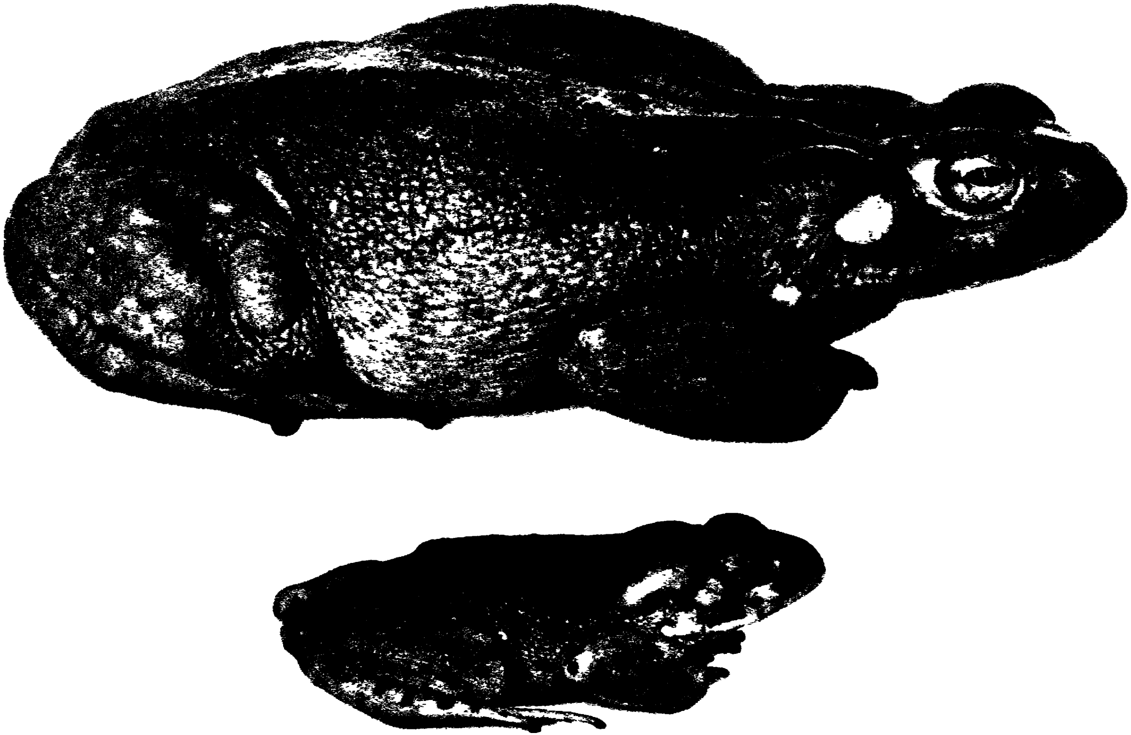


Fig. 1. *Bufo cognatus cognatus*, Great Plains Toad
Collected at Yuma, Arizona, September, 1912. About natural size

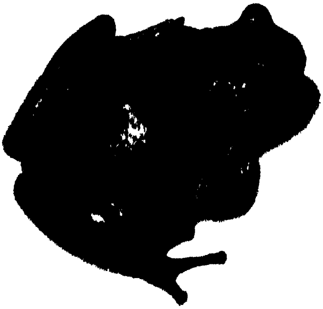
Figs. 2, 3. *Bufo cognatus californicus*, Arroyo Toad
Collected near Bonsall, San Diego County, California, May, 1927. Natural size

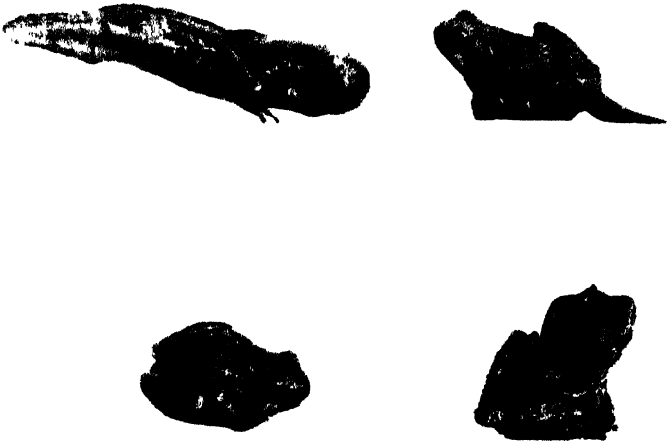


Bufo alvarius, Giant Toad

Fig 1 Adult Collected at Tucson Pima County Arizona August 1922. Natural size
Fig 2 Juvenile from Yuma, Arizona, collected September, 1912 Natural size

September 15 1928





Hyla regilla, Pacific Tree-toad

Fig. 1. Adult. Collected at San Francisco, California, June, 1912. Natural size.

Fig. 2. Juveniles from Los Gatos, Santa Clara County, California, May, 1915. Natural size.

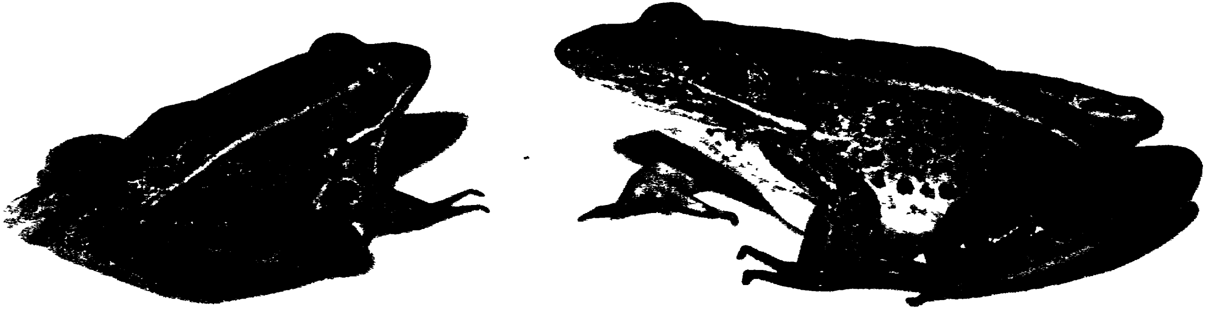
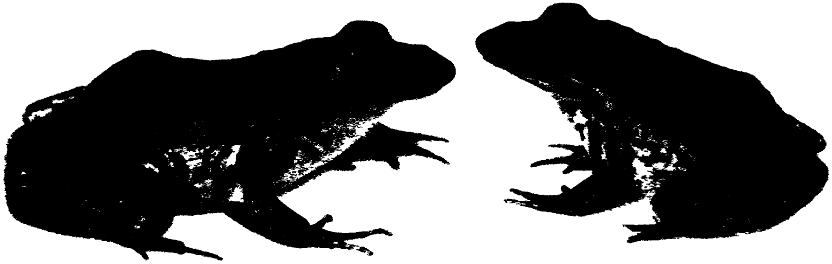


Fig. 1. *Pseudacris triseriata*, Western Marsh Frog
Collected near Salt Lake City Utah August, 1916 Natural size

Fig. 2. *Rana pipiens*, Leopard Frog
Collected at Elko Elko County Nevada July, 1913 About natural size



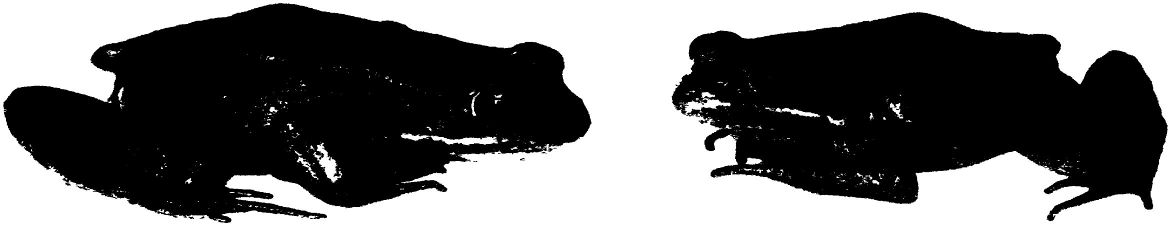


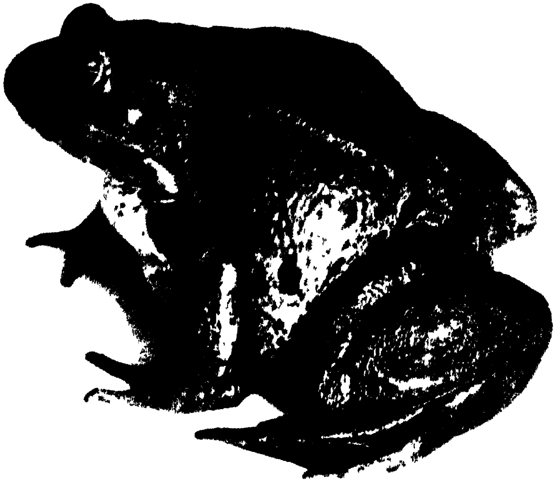
Fig. 1. *Rana onca*, Nevada Frog

Collected at Las Vegas Clark County Nevada August 1913 About natural size

Fig. 2. *Rana aurora aurora*, Western Wood Frog

Collected near Fischer's, Hoh River, Jefferson County, Washington, September, 1919

About natural size



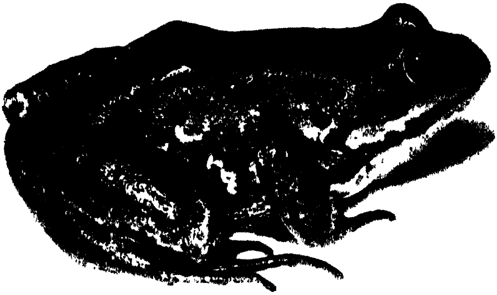
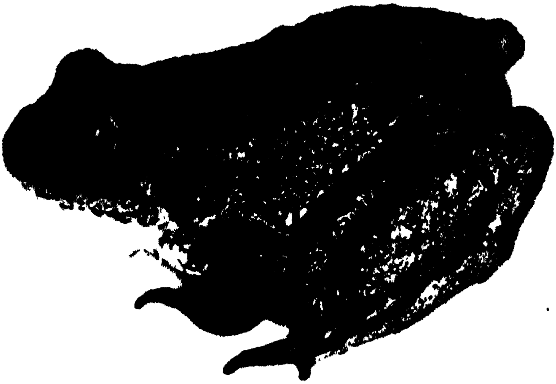


Fig. 1. *Rana aurora draytonii*, California Red-legged Frog
Collected at Los Gatos, Santa Clara County, California, June, 1915.
About natural size.

Fig. 2. *Rana pretiosa*, Western Spotted Frog
Collected in Mount Rainier National Park, Pierce County, Washington,
July, 1914. Natural size.



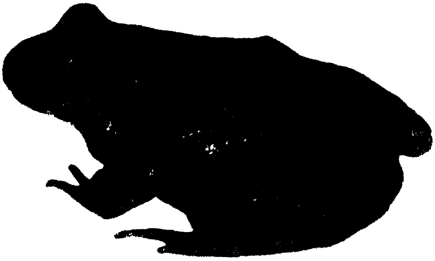
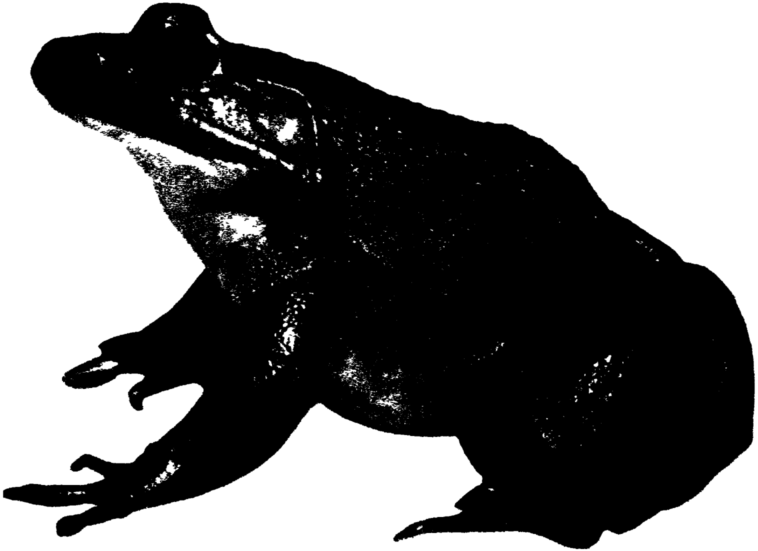


Fig. 1. *Rana boylii boylii*, California Yellow-legged Frog
Collected at Los Gatos, Santa Clara County, California, April 1922
Natural size, very large specimen

Fig. 2. *Rana boylii sierræ*, Sierra Nevada Yellow-legged Frog
Collected in Yosemite National Park, Tuolumne County, California, September 1922
About natural size



Rana catesbeiana, Bullfrog

Collected near Boise, Ada County, Idaho, August, 1916. About natural size.

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